



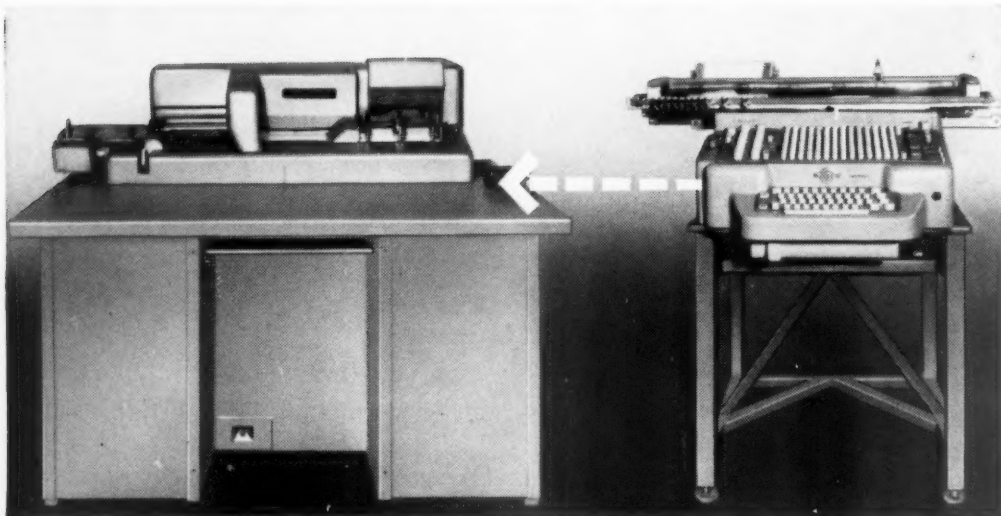
MARKET FORECASTING    ORDER HANDLING    ACCOUNTING    FINANCIAL AND COST CONTROL    DELIVERY SCHEDULING    STOCK CONTROL  
AUTOMATIC MACHINE CONTROL    PROCESS CONTROL    DATA LOGGING    PRODUCTION CONTROL    RESEARCH AND DEVELOPMENT

# *Automatic* Data Processing

- ▶ *Accounting on a Continental Scale*
- ▶ *Costing a Turbogenerator*
- ▶ *Four New Computers*
- ▶ **Full List of Contents Page I**

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# Automatic Data Processing

VOL I

No 9

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## COVER PICTURE

A model of the 500/mega-watt turbogenerator being built for the Tennessee Valley Authority by C A Parsons and Co. An article on Parsons' costing systems begins on page 8

## AUTOMATIC DATA PROCESSING

Published monthly by Business Publications Ltd, registered office, 180 Fleet Street, London, EC4. (Waterloo 3388). 45/- a year post free UK and overseas.

Advertisement, editorial and sales offices: Mercury House, 109-119 Waterloo Road, London, S.E.1. (Waterloo 3388).

Change of subscriber's address: Please notify publishers six weeks before change of address is to take effect, giving present address in full and new address.

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Editor **Erroll Wilmot**; Assistant Editor **Philip Marchand**; Art Editor **Douglas Long**  
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READING GUIDE

## READING GUIDE

## CONTENTS CONTINUED

Over a period of years the heavy engineering firm of C A Parsons and Company have evolved accounting systems to keep pace with the **complex costing problems** that confront them

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A report from John Diebold and Associates highlights the progress that has been made in the USA in the **numerical control of machine tools** and touches on the various systems available

page 16

Down under, the Australian Federal Treasury has devised a **data communications network** that links Canberra with seven major cities. This, with additional help from a computer and electronic calculators, enables the government to produce census and Treasury figures much more rapidly than hitherto

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Four **new computers**—two digital and two analogue machines—make their appearance and are described in detail

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Scientists are working on machines that will **read handwriting** and **print automatically from the spoken word**. Richard Fatehchand checks on the progress they have made

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A recent conference in Cleveland, Ohio, sponsored by Western Reserve University and the Rand Development Corporation discussed **information retrieval** and **machine translation** developments. Andrew Booth comments on the conference's work

page 35

Why do certain drills break when **controlled by automatic equipment**, and yet never do so when operated by human hand? Scientists at Birmingham University are probing into this problem

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Trying to take the drudgery out of the business of checking on retail stocks has thrown up a **system of control** that starts at the stage when retail goods are ticketed for the counter

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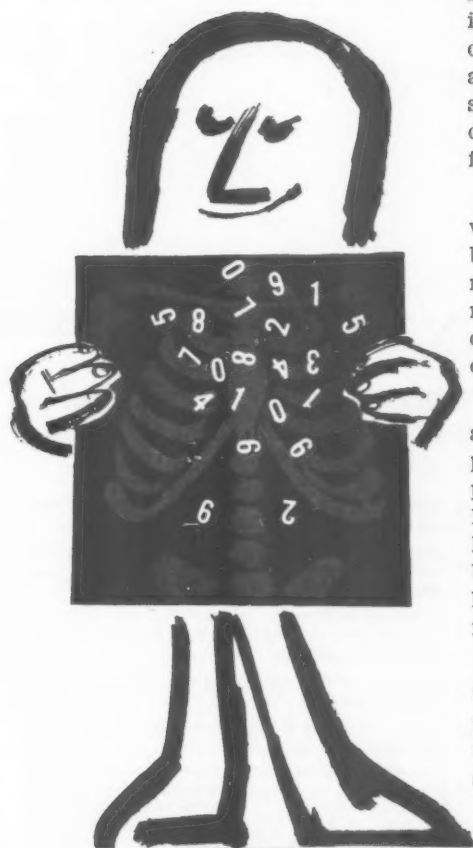
# AUTOMATION IN THE HOSPITAL

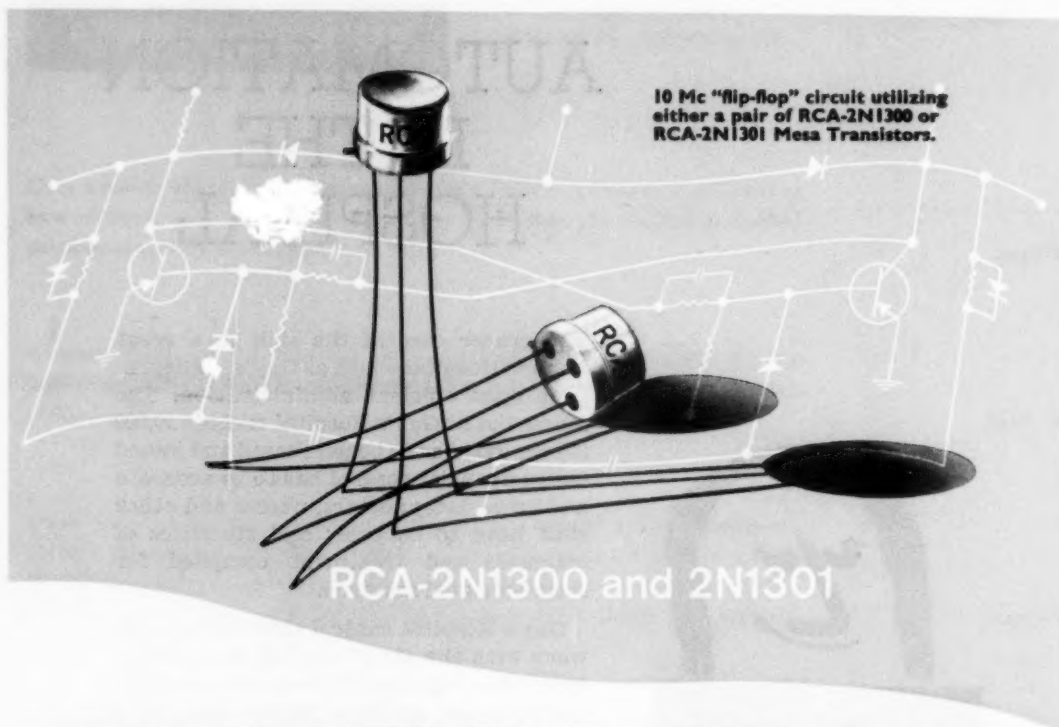
The proper care of the sick in a great London Hospital—such as Guy's—is dependent upon efficient administration. The stores list at Guy's Hospital exceeds 10,000 items; food has to be purchased and issued daily; financial control has to be accurate and up-to-date; doctors, nurses and other staff have to be paid; and statistics of diagnosis and treatment compiled for future medical research.

Guy's Hospital control this complicated work with the aid of an IBM installation based on a single highly flexible accounting machine and ancillary equipment. As a result, work no longer suffers from the drudgery, the delay, and the fallibility of old-fashioned clerical methods.

For a specialised task—the calculation and punching of average monthly stock prices on 10,000 store cards—Guy's Hospital use the facilities of the IBM Data Processing Centre. In this way they enlarge the scope of their own installation, because these cards are then used in the hospital for a further sequence of accounting procedures.

In hospitals, factories, and offices throughout the world, IBM Data Processing equipment is producing more and more up-to-the-minute information for control and effective decision by Management.





## LOW-COST MESA COMPUTER TRANSISTORS

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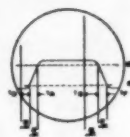
RCA-2N1300 and 2N1301 Germanium P-N-P Mesa Transistors offer these 10 major benefits to designers of switching circuits. And they're ready for you now!

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- high current ratings—improve overall system speed.
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads.
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors.
- especially well suited for use at pulse repetition rates up to 20 Mc.
- exceptionally well suited to applications in saturation-type switching circuits.

RCA TYPE	Maximum Ratings* Absolute Maximum Values				Characteristics: Common-Emitter Circuit, Base Input Ambient Temperature of 25°C		
	Collector to Base Volts	Emitter to Base Volts	Collector Watt- age	Transistor Dissipation—mW at 25°C at 50°C at 75°C	Minimum DC Current Gain at collector res. = 10	at collector res. = 40	Gain Bandwidth Product† Mc
2N1300	-13	-1	-100	150 75 35	30	—	40
2N1301	-13	-4	-100	150 75 35	30	40	60

\*Minimum collector to emitter  
voltage rating = -12 volts.

†For collector res. = 10 and  
collector to emitter volts = 1.



Oscilloscope wave  
form shows typical  
delay, rise, storage  
and fall times  
achieved with 10-ma  
inverter circuit utiliz-  
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MESA TRAN-  
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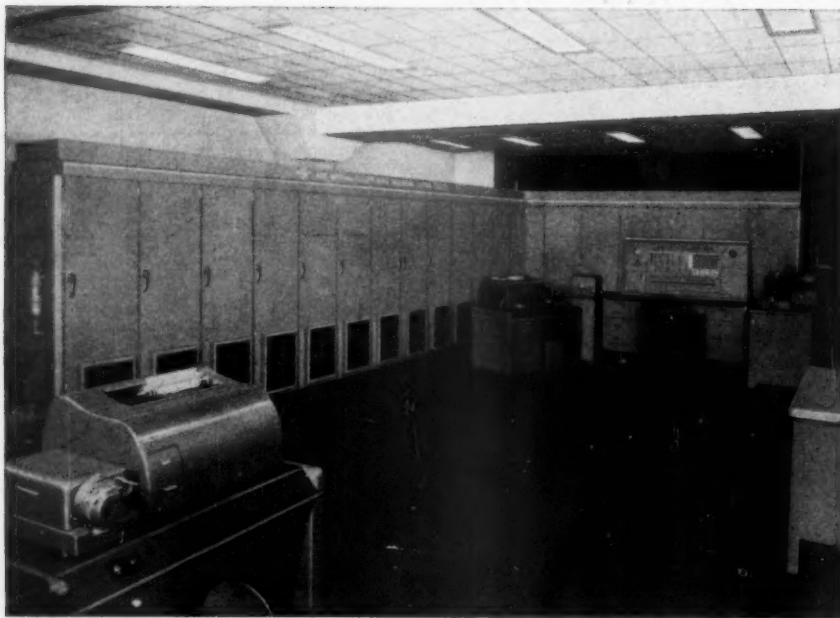


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Electronic computers of various types are already in use in considerable numbers in Gt. Britain; but of those developed specially for commercial and industrial accounting applications, the National-Elliott 405 leads the field as the one most widely adopted for carrying out full-scale *integrated* data processing programmes.

*Illustrated above:* a twenty cabinet all-purpose installation incorporating four magnetic film units (for 'writing' and up-dating the 'main data file') and a high-capacity fast access disc memory for the storage of (a) programmes and (b) data selected, automatically for actual processing. (Additional Magnetic Core Memory and other advanced developments are incorporated in the 405M System).



## **Electronic Data Processing Systems**

The National Cash Register Company Ltd (Electronics Group) - 206-216 Marylebone Road - London NW1 - Tel: PADDington 7070

### *THE POLITICAL PARTIES AND AUTOMATION*

IT may be unrealistic to expect serious political debate during a general election, but the lack of interest in automation and its social implications is a curious deficiency in all three major political parties. The subject attracted little notice during the election campaign, and enquiry at the party offices elicited only one publication dealing with it: *Automation and the Consumer*, published by the Conservative Political Centre in 1956. Neither the Labour party nor the Liberal party, apparently, has a current publication on automation, though the Trades Union Congress has two pamphlets based on a report made to the 1956 congress.

The introduction of automation to factories and offices will have profoundly important social consequences. Some can be foreseen, some can be guessed at, and some may, in the nature of things, take the most perceptive of us by surprise. It would seem to be a matter of elementary prudence for politicians to study the subject and make some effort to think about the problems that are bound to arise. We shall do our best to help, by providing factual information and intelligent discussion in the pages of this journal.

### *JOHN WORRAL*

WE have heard with sorrow of the sudden death, in Oxford, on 12 September, of John Worrall, who contributed the article, 'More Time and Scope to Manage,' to our September issue. He was taken ill a few minutes before he was to address members of the Corporation of Secretaries, and he died within ten minutes.

Had he lived, John Worrall would almost certainly have become a frequent contributor to this magazine. His unusual intelligence and imagination were immediately apparent, and he will be greatly missed by his colleagues in Shell-Mex and BP Ltd, where he was Assistant Manager of the Organisation and Methods Department. We offer our sincere sympathy to his widow and his two sons.

*Mechanical accounting, built up year by year, has solved*

# A Complex Costing Problem in a Heavy Engineering Industry

by ERROLL WILMOT

**T**HE United States Tennessee Valley Authority recently awarded a contract for a turbogenerator with a capacity of 500 megawatts to the British firm of C A Parsons and Company Limited. The contract, which is worth something in the region of 12 million dollars, was won in the face of fierce competition, not only from rival tendering companies but from the powerful lobbying of patriotic and quasi-patriotic pressure groups in the United States. The achievement reflects the status and the energetic enterprise of a company that has grown to pre-eminence from comparatively modest origins 70 years ago.

## **FOUNDED IN 1889**

The business was founded at Heaton, Newcastle, by Sir Charles Parsons in 1889, for the development and manufacture of steam turbines and high-speed electrical plant. The works then covered about two acres and consisted of a single

workshop, with a small pattern shop, a smithy, a test house and an office. The whole business employed 48 men.

When Sir Charles died, in 1931, the business employed 1,800 people and the buildings occupied an area of 25 acres. Today, 28 years later, 7,000 people are employed in the workshops and offices on 61 acres of land.

## **WORLD'S LARGEST TURBOGENERATORS**

The size of the product has grown proportionately with the size of the company. The early turbogenerators had a capacity of seven and a half kilowatts. The Tennessee Valley turbogenerator, which is not the largest to be ordered from Parsons', will have a capacity of 500 megawatts. A still larger one was ordered last year by the Central Electricity Generating Board for the generating station at Thorpe Marsh in Yorkshire. This is to have a capacity of 550

**AUTOMATIC DATA PROCESSING**

megawatts and will be the largest turbogenerator in the world.

### NUCLEAR POWER PLANT

With their probably unexcelled knowledge and experience, Parsons were engaged by the United Kingdom Atomic Energy Authority to design and construct the electric power plant for Calder Hall. The company has since obtained contracts for several other nuclear power stations, the latest being the Agip Nucleare Station at Latina, about 60 kilometres south of Rome.

In addition to turbogenerators, Parsons manufacture transformers of the small distribution type up to the largest generator transformers for electric power stations. The company's business thus involves the execution of a comparatively small number of individual orders, each having important characteristics peculiar to itself, each of great magnitude and high cost.

### DATA PROCESSING PROBLEMS

What are the accounting and data processing problems in a company engaged in production of this kind and on this scale?

In the first place, each order requires a large number of components, many machining operations, and labour. The costing is consequently highly complex, and is made more so by the system of contract labour in conjunction with a guaranteed minimum wage.

*The main office building of C A Parsons and Company Limited at Heaton Works, Newcastle*



*F W Gardner, Esq., B.A., Chairman of C A Parsons and Company Limited*



### CONTROLLING DOCUMENTS

The processing of data for every order undertaken by the company may be arbitrarily supposed to begin in what is colloquially called 'the Banda room,' where the essential controlling documents are copied on Banda spirit duplicators. A 'material specification' records the drawing number, order number, cost account identification and title of the job. In the illustration (Fig 1) the material specification of order number 3424 is one of eight sheets showing in detail each subsidiary job of all those comprising the entire order. The details have been shaded out in this illustration, with the exception of item number 23, for 16 dumb bell keys, which is recorded on its job card (Fig 2) and subsequently on the

appropriate sequence of cards of which random examples are shown in Fig 3.

#### **ORDER NUMBERS**

The aim of the costing system is to obtain a balanced analysis of expenditure under the headings of labour, material, disbursements, machine tool charges and establishment charges. Material is subdivided into direct purchases and stock issues from the company's stores. Each order is given an order number, or job number, and alongside this standard cost accounts are used to obtain the analysed costs of the subsidiary units. The class or type of work is distinguished by a prefix attached to each order number. The combination of prefix, order number and cost account number is referred to as the job number.

#### **LABOUR LINES AND CLOCK CARDS**

The original records for recording labour costs are known as either contract lines or time lines and are written out by ratefixing clerks on the shop floor.

When these lines are complete they are sent to the timekeeping section where individual man hours are calculated and the price for each job is checked to see that it is in excess of the guaranteed minimum.

The hours worked are recorded on the clock card whether the employee is engaged on time-work or piecework and before the payroll can proceed, complete agreement must be established between the time card and the hours recorded on the time lines or contract lines.

#### **LABOUR JOB CARDS**

The order number, time, contract award and other essential information are punched into Hollerith labour job cards, which are segregated according as they represent time lines or contract lines. The cards are balanced to batch totals between Friday morning and the following Monday evening. Next, the contract labour job cards are sorted according to employee check numbers, and a contract sheet is tabulated in duplicate for each employee. The top copy of the contract sheet for each employee is enclosed in the employee's pay packet; but the possibility is being considered of giving it to the employee on Thursday to enable any dispute or error to be attended to before the final making up of the week's pay on Friday.

From the contract sheets the timekeeping section enter the hours worked and the contract

award value on to the clock cards. These are then completed by calculation of the national award and overtime extras. The basic rates used for these computations are printed on the time card by addressing machine.

#### **THE PAYROLL**

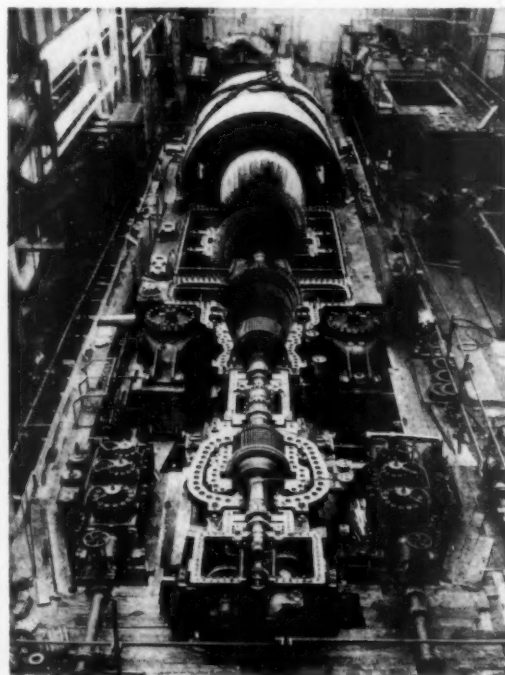
The clock card now shows all the details of the individual man's pay such as contract wage, time wage, national award, overtime, extras and standard deductions.

All this information is punched on to a payroll card and these cards are then sorted in order of employee check numbers and merged with tax record cards and the current tax deduction is calculated on the Hollerith 550 calculator.

The payroll itself is printed and also a pay slip for each man giving the details of his net wage.

#### **RE-SORTED FOR COSTING**

After the payroll operation the cards are re-sorted for the costing allocation under machine numbers and cost accounts. Various percentage rates are added to some classes of labour to absorb overheads. Costing is, of course, considerably complicated by the many different contract terms and rates of pay of the men working



*A 100-megawatt turbogenerator in course of construction in the workshops*

**AUTOMATIC DATA PROCESSING**

MATERIAL SPECIFICATION									
SCHEDULE DRAWING NO.		JOB NO.		JOB NO.		JOB NO.		JOB NO.	
/496/L131		3424		495					
TITLE: ASSEMBLY OF BRASS UNDER STATOR GAS COOLER DRAINS, AIR RELEASE PIPES ETC. ONE									
PAGE: 1 OF 8									
ITEM	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT
16	40-45 S	3	3508/3						
23	DUMB BELL KEYS								

Figure 1: A complete materials specification provides an analysis of each job at C A Parsons and Company Limited. One of eight sheets detailing items in order number 3424. The unshaded item (23) is entered on the job card in figure 2

JOB CARD																																							
SCHEDULE DRAWING NO.		JOB NO.		JOB NO.		JOB NO.		JOB NO.																															
/496/L131		3424		495																																			
TITLE: ASSEMBLY OF BRASS UNDER STATOR GAS COOLER DRAINS, AIR RELEASE PIPES, ETC.																																							
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23	DUMB BELL KEYS																																						
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Material	Quantity	Unit	Material	Quantity	Unit																																		

Figure 2: Job card. Every item of every job is recorded in this way

in gangs on each job, and by the fact that individual men work on several jobs in any one week.

### PURCHASES ACCOUNTS

For the purchases accounts, dual purpose Hollerith cards are used: invoice details are entered manually on the left half of the card and punched into the right half. Direct purchase cards are used for purchases allocated direct to job numbers. Where goods or materials are purchased for stock, material cards are punched and verified direct from original invoices.

Both sets of cards are sorted each month, coded according to supplier, and listed in the form of a purchases journal, showing a monthly total for each supplier. The tabulator is linked with the reproducer summary card punch to produce these monthly totals on summary cards. A credit journal and credit summary cards are similarly produced.

Suppliers' statements are collated with the purchase journal, and cards are punched to tabulate the payments book, part of the cash book, and to print cheques in continuous form for payment of accounts monthly.

The summary cards from the purchase journal and credit journal, with cash cards, are sorted

according to supplier number and fed into the collator with the previous month's ledger balance cards. If a transaction has taken place, the collator merges the balance card with the current transaction cards; if an account remains static the balance card is sorted into a separate batch.

As each ledger sheet is posted a new summary card is automatically produced.

### MATERIALS PURCHASES

The cards punched for direct purchases and materials are sorted for stores accounting into two packs, one for materials purchased for stock, the other for materials allocated direct to job numbers. The latter are filed for use in the preparation of the monthly cost summary. Stock materials issue cards are sorted according to stores control allocation numbers, and issues from each store are tabulated and balanced monthly.

### ADDITIONAL CHARGES

National award and overtime extras, taken from the clock cards, are spread over the various jobs that each employee has worked on during the week. The final allocation is punched into the labour job cards, which are run through the tabulator to balance them with the payroll.

Machine charges, calculated on an hourly basis, are also punched into the labour cards.

All the labour job cards are re-sorted for the costing allocation under machine numbers and cost accounts. A weekly labour summary card for each cost account is automatically produced by the reproducer summary punch linked to the tabulator.

Establishment charges are allocated to various classes of labour according to predetermined rates calculated to absorb the overheads of the company. The 550 calculator works out the charges for each labour summary card and punches the information into the card.

Figure 3: A selection of the cards employed as part of the data handling system

Figure 4: A contract line, lower left, and a time card, upper right, from which data will be transferred to punched cards

Establishment charges are allocated to various classes of labour and departments according to predetermined rates, which are adjusted from time to time. The application of these rates and the punching of the weekly summary cards are automatic. Sets of master ready-reckoner cards have been prepared for the calculation of establishment charges.

#### MONTHLY COST SUMMARY

During the course of each month there have been created weekly labour summary cards, cards for direct purchases, stores issues and petty cash expenses. These are sorted according to job numbers and run through the tabulator to produce monthly summary cards. These record job number, date, and monthly totals for machine charges, labour, petty cash, stores issues, direct purchases and establishment charges. They are then collated with the cards representing current work carried forward from the previous month. These are then summarised into one monthly cost summary card, listed on the cost summary to show details of all jobs in progress.

#### SALES, ASSETS AND DIVIDENDS

In addition to the payroll and costing pro-

cedures, the company's mechanised accounting system embraces sales, which is a much less complex operation, of course, than the costing, the annual writing up of a register of fixed assets, and the payment of shareholders' dividends.

#### LOGICAL EVOLUTION

The present accountancy and data processing system at Parsons' has evolved by logical if not easy stages from the 'manual' but nonetheless comprehensive system that grew up with the company in its earliest days. The decisive step in mechanisation, involving the complete analysis and reorganisation of the system, was to a great extent forced upon the company by the conditions of war in 1942. It was then that the Hollerith punched card machines were installed. The first payroll and labour costs analysis was run mechanically in November 1943. Before this could be done it was necessary to codify all

#### AUTOMATIC DATA PROCESSING

## MECHANISED ACCOUNTING ORGANISATION

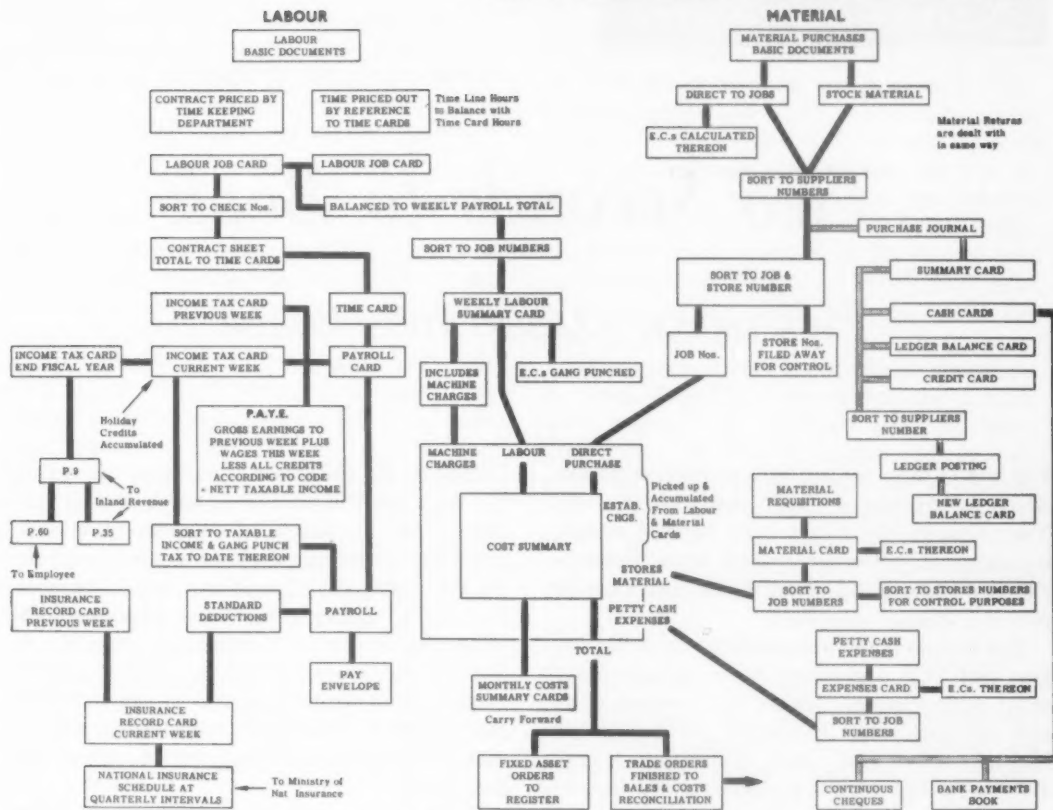


Figure 5: Diagram of the materials and labour sections of the mechanised accounting system in operation at Parsons'

information, to design appropriate stationery and to train adequate staff.

## PAYE ABSORBED

Early in 1944 materials purchases and issues from stores were added to the mechanised system. When the Government introduced PAYE income tax in 1944 the company was able to add this considerable burden to its accounting system without having to engage any extra staff.

Progressively, from 1944 onwards, the purchases ledger, establishment charges, dividend warrants, sales and national insurance contributions were mechanised.

## SOME JOBS FOR THE COMPUTER?

The system does not stand still. Recently the Hollerith 550 calculator was added to the punched card machines, tabulators and comptometers. It

is now becoming apparent that certain jobs, such as the calculations of time rates and contract rates of pay for labour, could be conveniently put on to a computer.

Although the company has a Ferranti Pegasus in constant use, it is not employed on accounting but is housed in the new nuclear research building and is used exclusively for engineering problems. The computer manager, Mr. Ernest Smart, disclaimed any unorthodox or special achievements for his computer section. Only routine calculations were being done, but the computer was not only relieving highly qualified engineers of routine drudgery but was making it possible, by doing several alternative calculations, for designing engineers to exercise a more discriminating choice in the solution of certain problems than was formerly possible. A large and very impressive analogue computer is at present under construction in the same building.

# *Two Seconds to Book*

## TCA ORDER A RESERVATION SYSTEM

FOR use in their modern seat reservation system, which is expected to begin operation in 1961, Trans-Canada Air Lines have ordered a fully transistorised computer system from Ferranti-Packard Electric Ltd, Toronto, Ferranti's wholly owned Canadian subsidiary.

This follows the announcement made earlier this year that TCA had placed a two million dollar order with Ferranti-Packard for booking office and communications equipment which included business transactors, local distributors, trunk distributors and computer couplers used in conjunction with the central computer. This latest order brings the total cost of the seat reservation system close to three and a half million dollars.

The computer system consists of two identical machines both capable of using a common set of magnetic tape and input-output equipment and employing solid state transistor circuitry through-out. It is intended for continuous on-line working and while one computer can be handling reservations, the other can be handling statistical work.

This central system will be located in Toronto and each of the large number of TCA booking offices located throughout Canada and the USA will have direct wire access to the mass of flight and reservation information stored in the computer memory. This will be carried out by means of transactors, general purpose computer input-output devices, which are the vital part of the system.

Basically, the transactor is a device which translates ordinary pencilled information into computer language, transmits the information to the computer and receives an answer from it.

Externally the transactor contains only a narrow slot into which a card is inserted. This card carries the pencilled information query and receives the computer reply in the form of holes punched along the edge of one end of the card. Each TCA booking office will be equipped with transactors, the exact number depending on the size of the particular office. The transactor operates in conjunction with a distributor which can handle a large number of transactors and whose function is essentially one of control and distribution.

The computer memory will contain all flight information necessary for the operation of the reservation system, including the number of seats available on all flights. Queries will arrive at the computer from any one of about 300 transactors, and the computer memory files will be consulted to provide the replies.

For example, if a reservation for two people were requested on a certain flight, the computer would 'look up' the particular flight in question. If two seats were available the computer would then send the information back to the transactor in the form of a punch in a specific location on the card. It would also deduct the two seats from its inventory for that flight and would then be ready to handle the next query.

Depending on conditions, other replies from the computer could be: 'flight cancelled,' 'no space' or, if the query card has been marked incorrectly, 'error.' If a 'no space' answer were given, the computer would suggest alternative flights on which space was available.

At present Trans-Canada Air Lines handles 3,500,000 transactions in flying 250,000 passengers

**AUTOMATIC DATA PROCESSING**

per month. The Ferranti-Packard electronic system will, it is claimed, reduce the number of necessary human transactions by 60 percent. In addition, speed of operation will permit reservation enquiries to be handled in approximately two seconds, regardless of the geographic location of the reservation source.

### **Giant Copier for the Patent Office**

THE first automatic xerographic machine to be sold in Britain was installed last month in the Patent Office, where it will copy nearly two million printed pages a year.

This machine—a £17,500 Rank-Xerox Copyflo—will be used mainly to solve the problem of copying Patent Specifications which have gone out of print.

There are about one and a half million British patent specifications in the Patent Office, and at present 400 new ones are published each week: it is impossible to maintain stocks of all these specifications and uneconomic to reprint specifications which are out of stock.

In the past the only way out of this dilemma has been by using ordinary photographic copying methods, which need costly sensitised paper and a great deal of labour, but these are now to be largely superseded by a system based on the Copyflo machine.

When a request is received for a specification which is out of print, the file copy will be micro-filmed page by page. The microfilm will then be processed and put on to the Copyflo which will enlarge the pages to their original size again by automatic xerography (electrical photography) on to plain, unsensitised paper at 20 feet a minute. The pages will then be cut and stapled.

Although the new system will add microfilming to the stages of the reprinting operation, there will be a compensating saving: filming will be done on the spot, so specifications will not have to be carried so far and will be returned to file more quickly. The microfilm, which is very cheap, is used merely as a throwaway intermediate.

Sorting of the finished prints, which has in the past been a big problem, is entirely eliminated as the pages come off the Copyflo in roll form in strict page sequence.

The Patent Office are adopting the new system because they believe that the size of the reprinting problem calls for an automatic copying system. It is expected that the system will reduce the time needed for production of copies.

### **The One-million Pound Computer**

FOLLOWING on the recent announcement by the National Research Development Corporation that it would support the development of Atlas, a large capacity high-speed transistorised digital computer, comes the news that computer engineers of Manchester University and Ferranti Ltd are now engaged in constructing the first machine which will be installed at Manchester University. It will be working probably at the start of 1962 and will be the prototype for the Ferranti Atlas production models which will cost about one million pounds each.

Atlas will be a very fast machine: the simple operation of adding a number into the accumulator register, an internal part of many instructions, will take 0.2 microseconds to complete, and more complicated functions of the computer will be correspondingly faster than with current machines, while a special feature of Atlas will be the ability to switch to another programme if the main programme is held up for any reason.

### **New Company for Control**

A NEW Anglo-American venture to design and manufacture automatic control systems for industry, Hagan Controls Ltd, has been initiated by The Plessey Company Ltd, of Ilford, and Hagan Chemicals and Controls Inc, of Pittsburgh, Pennsylvania.

Plessey hold 90 percent of the shares in the new company which is to begin operations at Ilford immediately.

Hagan Controls Ltd will have the manufacturing and selling rights for the entire range of Hagan automatic control equipment, devised for maintaining physical conditions within given tolerances, and also for Kybernetes data processing equipment in Great Britain and the Commonwealth except Canada.

Hagan Chemicals and Controls Inc has many years of experience in process control and is one of America's leading companies in this field.

Typical applications for Hagan equipment are in boiler control and process control for a wide variety of industries such as the manufacture of steel, glass, paper and in electrical generation and marine engineering.

The new company's board comprise Mr A G Clark (Chairman), and Messrs M W Clark, E J

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*Continued on page 50*

# Numerical Control of Machine Tools

**THE numerical control of machine tools is one of the most far reaching developments in the automation field. It represents a singularly effective combination of automatic handling of information and the automatic handling of production parts. Contrary to many automation systems, numerical, or digital, control of machine tools has flexibility as one of its prime objectives, making it a means of bringing automation to the company manufacturing a variety of products in small lots. In America, where large scale, mass production is considered so prevalent, estimates indicate that 80 percent of production is still in lots of 25 or less.**

**A**T the present time numerical machine tool control remains largely in the pilot plant stage, although it is being used by a number of companies on a production basis. Present costs are very high, and a variety of approaches are still competing with each other for acceptance. But there is little question that in future prices for the necessary equipment will become more reasonable and greater skill will develop in applying numerical machine tool control to production.

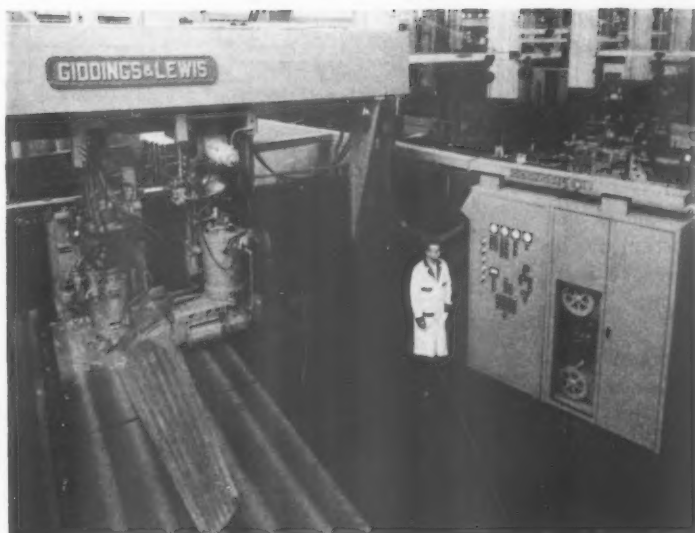
While it is a little difficult to place the exact start of the present numerical control efforts in metalworking, no doubt it had its basic roots in the rapid growth of servo controls and prime movers associated with radar antenna equipment developed during the second world war. The General Electric Amplidyne, advances in hydraulic servo design, and the Massachusetts Institute of Technology Servo-mechanisms Laboratory had a strong influence, together with other early work, in making current developments possible. The MIT contract work for the US Air Force was the prominent single project which gave the programme

direction. This was a dramatic piece of work, and it had two outstanding effects: (a) it demonstrated what could be done from a feasibility standpoint, and the results were truly exciting, showing a whole new area of advance for the metalworking field, and (b) it was intended to be an aggregate of equipment using primarily existing components and techniques, to mate with the existing 'Whirlwind' computer developed by MIT, and was not expected to serve as a prototype for either equipment or system design. The net effect was that the large and expensive nature of the resulting design intrigued the machinery industry people, but also convinced them that they had better wait for later and less expensive embodiments before committing themselves heavily in this direction.

## NEW MANUFACTURING CONCEPT

Another result, which has had a much larger implication, is that the concept of a whole new 'manufacturing' system—from blueprint to finished part—was evolved, and this cannot help having a

**AUTOMATIC DATA PROCESSING**



*Giddings and Lewis machine tool control equipment, employing linear interpolation process.*

major impact on the metalworking industry, including its machine tool and control system vendors. In this enlarged form, the over-all system starts with the basic part drawing or blueprint (in a form and style which must inevitably include such special detail as the numerical control system which follows it may require) and carries through the steps of planning, methods, detail, and selection of appropriate tooling and fixtures. The result is a set of encoded instructions on tape which 'defines the part.' From here on, the further processing is accomplished by machine (in a manner depending on the system employed) and if the machine tool is properly loaded and set, will provide a finished part.

From a management standpoint the following definitions are of especial importance:

*Positioning Systems:* These are the simplest types of tape-controlled devices, which provide controlled end co-ordinates only, and are adaptable to drilling, boring, simple turning, spotwelding, etc.

*Contouring Systems:* More complex, these systems provide control of the cutting or forming members throughout the continuous motion path—ie, continuous definition of displacement and velocity between end values.

*Analogue control systems* are those in which the original data or control means involve continuously changing values of a selected parameter not otherwise defined by a numerical reference; although often less expensive, they are not suitable for

numerical control unless they are 'surrounded' by *Digital* references. Systems involving only digital techniques, or appropriate combinations of these two approaches, are usually required for the high precision that metalworking requires.

*Closed-loop* systems are those that measure the output, feed it back and compare this value to the input command, and control the response in a sense to reduce this difference to an arbitrarily small value. 'Self-correcting' systems of this type (either in whole or in part) are usually essential in machine tool applications.

#### **INTENSE COMPETITION**

The numerical control field is still fairly much in its infancy insofar as customer adoption is concerned, although there is intense competition already in evidence for a currently 'thin' market.

Commercial programmes have been scattered among several manufacturers, for the most part either poorly-conceived and inadequately financed efforts by firms with other, military efforts under way, or more thorough programmes by companies who mean to remain in the market in solid fashion. The commercial programmes have been primarily in the positioning field.

#### **AIR FORCE GIVES IMPETUS**

The US Air Force tooling programme has put significant life into the contouring field, and about 100 numerically controlled tools will be in the field in 1959, ranging from small profilers (4' x 4')

to large skin mills and profilers (up to 12' x 80'). These are being supplied by machinery manufacturers such as Giddings & Lewis, Kearney & Trecker, Cincinnati, and Morey, in association with certain control manufacturers. In fact, the Air Force programme has been the main impetus behind a great deal of the progress to date. Because of the shift in emphasis from manned aircraft to missiles, no further Air Force procurements are now expected until there has been a new look at tooling needs of the missile programme.

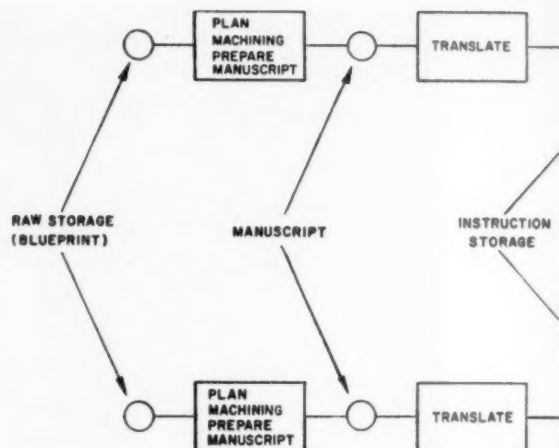
The 'third round' is now emerging, however, in part as an outcome of the Air Force programme, wherein the controls manufacturers are using their Air Force experience to accelerate their entry into the commercial market, with the same or a similar product. For contouring, the pattern seems to be simplified data preparation; use of general purpose computers, at least by the aircraft companies or 'Tape Centre' service by others; storage of basic 'block-type' input data on punched tape; and magnetic tape for play-back control where the Director (or path interpolator) is not at the machine tool itself. Improved designs are evolving and prices are becoming a significant factor. The leaders in the field are similarly entrenching themselves in the positioning field, where the emergent pattern seems to be clearly for simple data processing and punched tape storage.

#### COMMERCIAL SYSTEMS

The most significant step in purely commercial use of numerical machine tool control has been the recent opening by General Electric Company of a factory for large, low volume industrial products. This factory represents the largest single application of digital control methods for machine tools. General Electric is of course a manufacturer of such control systems, so that it is difficult to determine the extent to which the system is economical in itself and the extent to which it is a model. One of the most sophisticated applications of numerical control, in prototype form, has been the linking of three separate machines through numerical control by the Hughes Aircraft Company in California. Here the concept of numerical control has been extended from controlling the operations of one machine to directing and co-ordinating three separate tools. Carried to its full potential, such a concept could be developed into flexible assembly lines.

#### COMMERCIAL ADVANTAGES . . .

From the businessman's point of view, there are certain obvious benefits that make numerical



A COMPARISON OF MACHINE TOOL CONTROL SYSTEMS.

Explanatory notes:

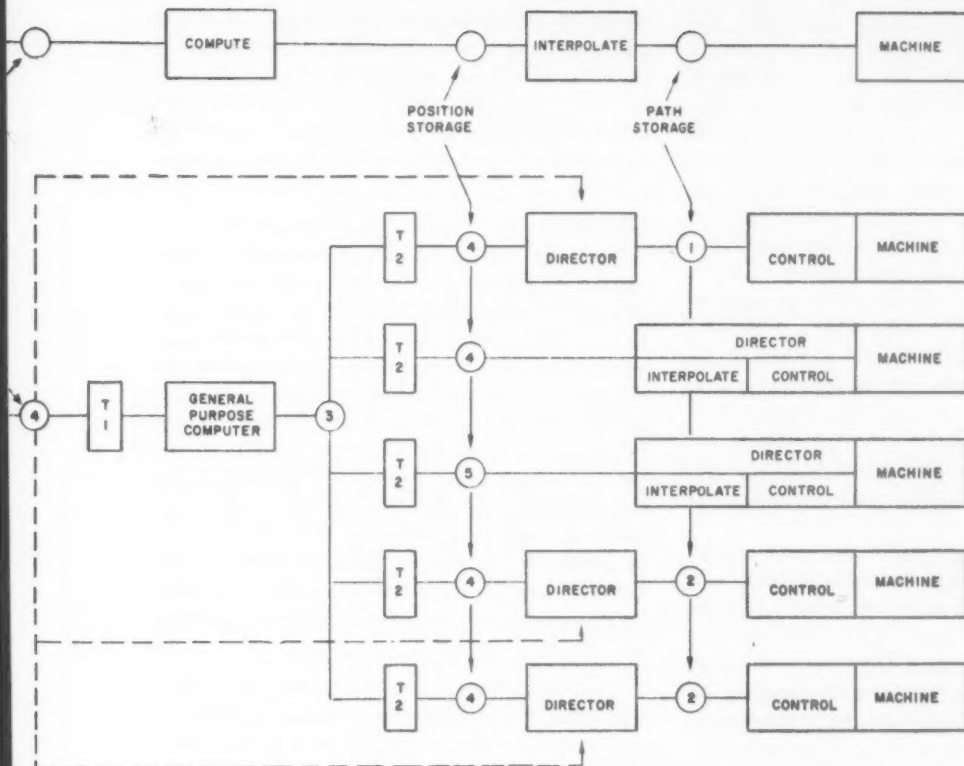
1. Phase interpolated magnetic tape.
2. Pulse interpolated magnetic tape.
3. Pulse block magnetic tape.
4. Punched tape block data.
5. Punched card block data.
- T1. Convert 4 or 5 to 3.
- T2. Convert 3 or 4 to 5

machine tool control interesting, at least for the future.

1. Lower machine set up time and costs.
2. Higher and more uniform quality.
3. Significant decrease in the time cycle between design and production.
4. More flexible production policies.
5. Reduction in demand for skilled labour to tend and set up machines.

#### . . . AND DISADVANTAGES

Against these advantages must be set the high cost of numerical control and related computer equipment, the increases in requirements for electronics and programming personnel, and the organizational complications of introducing such new elements as programmers and computer people into a factory situation.



## OPERATION OF NUMERICAL CONTROL SYSTEM

The following section attempts to review some of the basic steps that are involved in producing a part with a system of numerically controlled machine tools. The chart and description of steps show the basic pattern of steps involved, together with a comparison of several systems that are now operating and available.

1. The process starts with raw storage, consisting of the basic information concerning the part and how it should be made. This information would include drawings containing geometry of part, cutter size, feeds and speeds of operation, and so on.

2. The raw storage or basic data is then taken to prepare a manuscript to serve as the basis of the subsequent translation and computing steps. The main attribute of the manuscript is that it contains the raw data in sequential form suitable for translation.

3. The translation step consists of coding the material in the manuscript so that it is in a language, and in a form, suitable for computer use. The preference at the present time is to store these coded instructions on punched tape.

4. The subsequent steps involve computing from the translated and coded data to obtain the direct instructions for the machine. At the present time, this phase usually involves two steps. The first uses a general purpose computer for the basic processing, while the second step involves adapting the output from a general purpose computer into an interpolated form for final use. In some systems, the second step involves a separate piece of equipment, called a director, while in other systems the director function is combined with the other control equipment.

5. The final result is a storage medium containing the interpolated path for the tool and instructions for auxiliary functions.

## INTERPOLATION PROCESSES

One of the key elements in the entire process of preparing the instructions is the interpolation process. There are three basic interpolation techniques. One of these, used by the Giddings & Lewis and Bendix systems, is linear interpolation. Linear interpolation implies that all curves are made as chordal approximations; a general-purpose computer can be programmed to select the necessary number of chords and their location to fair a circle or any arbitrary curve within a specific tolerance. If a six-inch diameter circle is to be programmed for a smooth finish, and a chord length of 0.01 inch is used, nearly 2,000 data blocks will be required to specify the circle. One system uses only parabolic approximation. Two systems use linear and second-order approximation techniques. In the latter case, the six-inch circle can be defined by data block.

Because of the large number of data blocks involved in the Giddings & Lewis, Bendix, and Cincinnati systems, it is nearly mandatory that the chordal data for curved parts be prepared for their systems via some type of general-purpose computer. In the interest of uniformity of data handling for numerical control systems, the ECS (Electronic Control Systems) and Ferranti systems have been shown in the diagram as receiving their data from a general-purpose computer also; it should be clear that far less data are required in these latter systems.

## GENERAL PURPOSE COMPUTERS

A general-purpose computer (such as the IBM 704) which is at present available in many aircraft plants, has been proposed as the uniform means of processing data for all of the systems. While such a computer is technically capable of performing a large part of the task required, two points should be clear:

a. No general-purpose computer in its present form can directly prepare magnetic input tapes for any of the systems. A director to translate the output block data from a general-purpose computer into an interpolated form is required by most systems. In others, it is still necessary to convert from the magnetic block-data output tapes, so that it is acceptable as an input to the control systems.

b. General-purpose computers are extremely high-speed devices, and it is economical to operate them only if a very high-speed input and output data medium is used. Usually this consists of digital block-type magnetic tape; consequently, in the diagram appropriate translation devices are

shown to change the data into magnetic-tape form and back from it to accommodate the computer to the other associated equipment. While it is technically possible to modify directors to read the general-purpose computer magnetic output tape directly, this is believed to be economically questionable.

## LOCATION OF INTERPOLATION STEP

It should be noted that some control systems employ an interpolator separate from the control apparatus at the machine tool. By using either pulse or phase-interpolated magnetic tape for path storage, it is possible to minimize substantially the volume of electronics at the machine tool, and it permits the use of an optimum storage medium (ie, magnetic tape) for the large volume of data an interpolated contour requires. Although it has not yet been accepted by industry, some have proposed that a magnetic tape using pulse format be considered as the standard for path storage, although now two major systems perform the interpolation function within the electronics package.

## SIMPLIFIED METHODS FEASIBLE

The broken lines on the comparison chart show that three systems have the potential capability of preparing tapes for machine control without using a general-purpose computer. Instruction storage existing as punched tape with block data can be furnished directly to the appropriate director. In two cases the necessary auxiliary calculations comprise only calculation for cutter offset if only straight lines and circles are involved. Inasmuch as it has been estimated that between 70 percent and 80 percent of manufactured parts for aircraft can be described appropriately by the use of only straight lines and circles, this is not a difficult matter for the aircraft industry. For example, one system recently has programmed a test piece, using only a Marchant Calculator in addition to a director.

However, the possibility of using these systems without general-purpose computers cannot be stressed too heavily. If the flow of numerical data for all parts must always pass through a general-purpose computer, unjustifiable delays and expense will certainly be involved. From the standpoint of uniformity of approach, it may be consistent for all of the systems to operate via a general-purpose computer when they are initially installed in plants. Clearly an alternate approach, using a minimum of equipment, must be made available to manufacturing personnel if numerically-controlled milling machines are to be received willingly on a long-term basis.

# Automatic Accounting on a CONTINENTAL SCALE

by KEITH BEAN

**The Australian federal government in Canberra uses modern electronic equipment in conjunction with teletype communication systems to keep in constant touch with census and treasury statistics in Sydney, Melbourne, Brisbane, Darwin, Adelaide, Perth and Hobart**

**F**IVE thousand people live in the City of London, but 350,000 work there. Why, for goodness sake? It is appalling to contemplate the hundreds of thousands of hours they waste daily simply in getting to and from their offices, mostly jostling each other in overcrowded trains and buses. Morale and efficiency must suffer and are further eroded by the lunch-time struggle, queueing or elbowing a way into eating places where city-centre values put a premium on comfort. It is patently a budgetary waste, too, to have serried rows of stenographers and clerks occupying this high-rental, high-rated, city-centre space.

It is also unnecessary. Obviously the boss and a chosen few have to be at the heart of the metropolis but the big battalions of commuters

are an anachronism—an anachronism the removal of which would bring bounteous community blessings in better town-planning and freer-flowing transport and would be good business for individual firms too.

## **DECENTRALISING CLERICAL STAFF**

Automatic data processing equipment can not only reduce the vast hordes of typists, clerical and other workers but, coupled with teleprinters, teletype, radio and television links, can make it economic to re-site their work in the suburbs or right out of town. Electronics make communication between head office and the outlying administrative block no problem at all.

The efficiency of linking computers and other automatic machines with high-speed communica-



The headquarters building of the Australian Academy of Science, in Canberra, was opened by the Governor-General of Australia, Sir William Slim, on May 6. The body of the building is contained within the massive dome, of 156-foot diameter, which is surrounded by a moat, in which the supporting arches rest. The dome is 45 feet high at the centre.

tions is most clearly demonstrated by organisations which work on a countrywide or a worldwide basis.

The parent company of Monsanto Chemicals, for instance, wants a monthly correlated statement of operations from its worldwide subsidiaries. In the old pre-computer days it took three weeks to prepare and necessarily involved many amendments right up to the last moment. Now it takes three or four days and revision is reduced to a minimum.

#### MINISTRY OF AGRICULTURE SUBSIDIES

The large computer installation of the Ministry of Agriculture at Guildford illustrates the point on a countrywide scale. Among other jobs, it processes 2½ million farmers' subsidy payments a year, worth £250 millions. Since the subsidy on fat stock, for instance, often represents the farmer's profit, to retain his goodwill—and thereby help the achievement of the subsidy's objective—it is vital that he should get it quickly. But the payment is calculated on complicated statistics

and on even the most efficient conventional machines it involved nineteen operations and a three-week delay. Computers are now doing the job in one operation and the farmer gets his subsidy in five days. They have also, incidentally, cut a staff of 80 down to 15—a saving of £40,000 a year—and do the editing which used to require skilled scrutineers.

#### ELECTRONICS IN AUSTRALIA

An example of electronics applied on an even larger geographical scale comes from Australia—a continent about the size of Europe without Russia or the United States without Alaska. An Australian government booklet, *Electronics Help Speed the Nation's Business*, details the work of automatic data processing in the Treasury and the Bureau of Census and Statistics. The federal capital, Canberra, now claims the largest battery of statistical machines in the southern hemisphere.

The installation, supplied by Hollerith (Australia) Pty Ltd, a subsidiary of ICT, includes a Type 1201 computer, Type 555 electronic calcu-

**AUTOMATIC DATA PROCESSING**

lators, more than 20 tabulators, card sorters, four collators and interpreters, 12 mark-sensing reproducing summary punches, 40 automatic card punching and verifying machines and a five-channel unit which converts information from perforated tape to punched cards.

The booklet begins with an exposition of the Treasury work and particularly the Treasurer's monthly statement. This statutory statement involves analysing over 4,000 different accounting heads covering receipts and expenditure which exceed £A400 millions a month.

#### TELETYPE LINKS WITH CANBERRA

'Not long ago,' says the booklet, 'the end of each month found Treasury officers in Canberra awaiting the arrival of the airmail from Northern Territory. They relied on it for the statement of that month's financial transactions from the Sub-Treasury at Darwin (2,000 miles away) without which the progressive monthly statement of total Commonwealth expenditure could not be issued. Today a girl operating a teletype keyboard in Darwin is simultaneously punching out the required information at the Canberra end of the circuit. Similarly, from the Sub-Treasuries in Melbourne, Sydney, Brisbane, Hobart, Adelaide and Perth teletype links feed in details of the month's transactions to Canberra where simultaneously other machines process the information and give it its place in the giant mosaic of national receipts and expenditure exceeding £5,000 million in a year.'

'The result is that the Treasurer's monthly statement is now published on the third working day of the following month. For the previous 30 years its earliest publication, achieved only by shock effort of human minds and hands working long hours, had been the tenth day.'

The principal accounting records in the Treasury itself are in a thousand different accounting heads. These are used in reporting to Parliament and in controlling the subsidiary accounts which record expenditure in greater detail according to the appropriations of Parliament.

#### ENORMOUS QUANTITY OF DATA

Before the Treasury introduced electronic equipment the voluminous trial balances into which each month the Sub-Treasuries wrote details of their transactions had to be manually processed in Canberra. An enormous amount of detail from the six State capitals, Darwin and overseas centres like London and Washington had to be extracted from the trial balances for manual

re-typing on appropriate ledger cards and consolidated into the total for the Commonwealth as a whole.

Under this arrangement it was not possible to complete the posting of the Treasury ledgers in time to publish the preceding month's transactions by the tenth day of the following month, so each State Sub-Treasury had to condense the details into another ledger and send this summary to Canberra—in addition to its detailed trial balances. By use of this separate condensed record the statutory monthly publication was achieved.

#### DUPLICATION ELIMINATED

The use of teleprinter circuits and the machines to process the data have made it possible to abolish this separate summarised record, to publish on the third day of each month a statement based on financial results recorded in detail within the thousand heads in Canberra, and to end the need for Canberra to duplicate the typing already done in the States.

Since July, 1958, the records of each Sub-Treasury have been prepared for Canberra on perforated paper tape, using, at first, teletype for off-line purposes and, later, similar machines designed for commercial use. The list of balances from the thousand ledger cards in each Sub-Treasury is typed on a page, simultaneously yielding a perforated five-channel paper tape containing the identical information. This tape is passed through the teletype transmitter to the Treasury in Canberra. There it is converted into conventional 80-column punched cards. As each section is completed from all Sub-Treasuries, the cards are sorted and then passed through the electronic computer.

These cards, with progressive summary cards

A Hee 1201 General Purpose Electronic Computer of the type installed in the Federal Treasury in Canberra.



for the transactions of each Sub-Treasury under each item to the end of the preceding month, are then read and two things occur simultaneously—(i) the cumulative total for each item to the end of the preceding month, the grand total of transactions for the whole of Australia for the current month and the total for the financial year to the end of that month are printed and (ii) new summary cards are cut for each State office.

### ONE MANUAL KEYBOARD OPERATION

In a subsequent printing a tabular statement is prepared for each State office and sent to it. This constitutes, firstly, the trial balance of the Sub-Treasury ledger for that month and is the perfected page print of its balance. Secondly, it provides a check of the cumulative total shown in the State ledgers (which so far are still kept on conventional accounting machines) to ensure that the Commonwealth ledger in Canberra is perpetually reconciled with the constituent progressive State office totals. The one typing of figures in each Sub-Treasury on a machine which actuates a similar machine in Canberra is now the only manual keyboarding operation required in the production of the final consolidated progressive statement each month for all Australia.

The total time taken to process the punched cards on the computer, for every transaction throughout the Commonwealth, is only five hours.

### CHEQUES AND LEDGERS FROM TAPE

Most individual items of Commonwealth expenditure are cheques paid to meet traders' accounts. Hitherto this involved two operations, cheque writing and subsequent posting for ledger analysis. These are now combined, with the same basic five-channel perforated tape serving as a common language. The machinist types the cash payments journal and, as a by-product, produces two tapes—one with the information which is transcribed automatically on the face of the cheque and the other which is converted into punched cards for ledger analysis. Conventional ledgers have been abandoned.

Apart from the elimination of manual keyboarding, the equipment economises in the preparation of cheques for repetitive payees, who account for over half the volume of cheque writing. Thus there are incorporated in the programme of the machine instructions which govern the writing of the cash book and cheques, standard addresses, names of repetitive payees

and a code for ledger analysis. Similarly, all tabulations, stops and line feeds for the writing of cheques and cash books are automatically carried out by the machine from the paper tape programme.

### PAYROLL, CENSUS AND TAXATION

Other work of the Canberra installation includes:—

- Payroll for 10,000 staff, with the annual statement of earnings, superannuation, tax deductions and so on for each worker already available on the last pay day of the year.
- Accurate population estimates every three months—which made possible the announcement that Australia's population would reach 10 million on March 10 this year and 12 million by 1967.
- Income and taxation figures.
- Export and import returns covering 1½ million items.
- Consumer spending as reflected through the census of retailers.

Of the export and import returns, covering monthly information about trade of more than £100 millions a month, the booklet explains that 2½ million cards pass through an average of 40 machine processes. 'Officers of the Bureau of Census and Statistics are working continuously,' it says, 'on systems analysis and programming requirements to get out the trade returns more quickly and more economically. By combining operations which, on electro-mechanical tabulators, require several card passages, the electronic computer will save time and work.'

The returns on consumer spending Australia regards as a vital measure for government, traders and manufacturers. They are maintained by a complete retail census every four years and sampling every three months. This is a job for the 555 Calculator. Returns come from 130,000 retailers on forms which ask 120 questions. With such a complex document many errors of completion result but the 555 is programmed to ensure that answers do at least agree among each other on any one form. It ensures, for instance, that a return said to be from a milk distributor does not quote a much higher total turnover from groceries than from milk. The editing programme for this application on the 555 employs 139 steps. Returns are checked at the rate of 6,000 cards an hour.

Electronic calculators with magnetic drum storage have meant a saving of £400,000 a year to the taxpayers of Australia.

# New Computers

## 1—Elliott's compact 803 machine

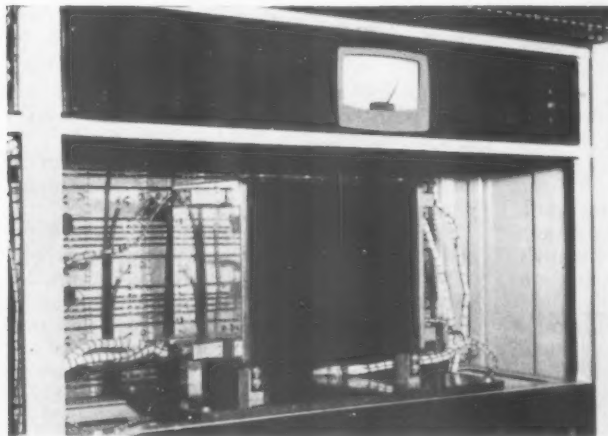
THE new electronic digital computer announced by Elliott Brothers (London) Ltd styled 803, is small, powerful, versatile, economical, reliable, and simple to use. It is a general purpose machine suitable for all types of work from business arithmetic to the solution of mathematical problems and the control of industrial processes. Entirely contained in a single cabinet, except for the control desk and input and output mechanisms, the 803 retains all the characteristics of larger and more elaborate machines at a fraction of their cost.

Combining the accuracy of a 39-bit binary word automatically checked for parity on all transfers to and from the 4096 word magnetic ferrite core matrix store by Mullard, which is immediately accessible in all locations and available for B-line modification of the order from all locations, 803

uses the Elliott High Speed punched paper tape reader as its input mechanism, to read in up to 150 characters per second, and produce a punched paper tape output on the Creed HS25 punch.

There are no valves at all in this machine, and all logical, control and storage functions, are performed by magnetic cores switched by junction transistors. The conversion of the AC mains supply to the low voltage direct current required by the transistors is effected entirely by solid-state devices, handling little more than 500 watts on a single-phase supply.

The 803 operates in the serial mode, with parallel access to and from the store, and completes an addition cycle in 720 microseconds. Optional alternative input mechanisms include the Elliott punched card reader, and a keyboard for manual input. An adaptation of the Elliott 35mm



*The magnetic ferrite core matrix store, made by Mullard, occupies a corner of the cabinet of the Elliott 803 solid state digital computer*

magnetic film storage system which has been successfully used for bulk filing in the National-Elliott 405 data-processing systems for over two and a half years, is currently under development.

The initial production programme caters for 14 machines, of which nine are now on order, including eight for export to the USA, following the delivery earlier this year of the Elliott 802, the first British computer to enter the United States.

The first 803 destined for the USA was exhibited at the Instrument Society of America Show in Chicago during September, as part of the 609 process control system of Information Systems Incorporated. A 609 system to be installed will be at the Gulf States Power Company's Nelson Station at Lake Charles, Louisiana. Sometime next year, two more 609's will be delivered to the E I du Pont de Nemours and Company chemical processing plant at Beaumont, Texas.

#### SPECIFICATION:

**Construction:** all the logical units of the computer and the core store are contained in a single cabinet which is connected to the control console by cable. The cabinet measures 66 inches x 16 inches x 56 inches high.

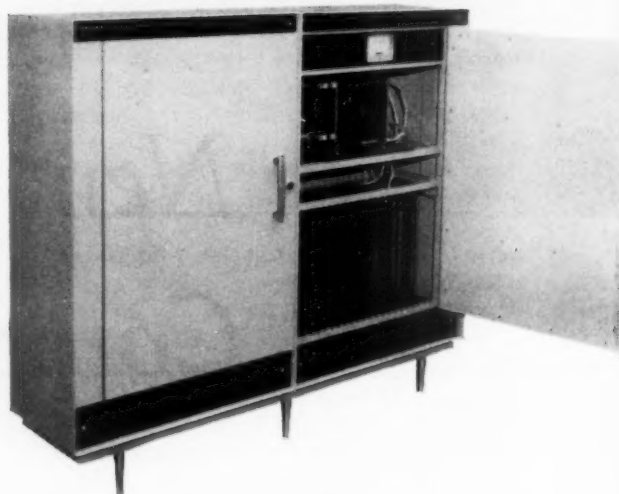
**Input:** by punched paper tape, read by the Elliott High Speed Tape Reader.

**Output:** by five-hole punched paper tape, punched on the Creed HS25 and subsequently interpreted off line.

**Optional Input and Output:** any device capable of transmitting or receiving digital data could be attached for special purposes. Such devices include the Elliott Punched Card Reader, manual keyboard and direct digital display.

**Storage:** magnetic core store of 4092 words of 39 binary digits plus one parity digit each, together with four words of fixed instructions. Parallel access.

**Arithmetic Unit:** digit rate: 166,500 per second; mode and notation used: serial binary; word length: 39 bits.



*The cabinet of the new Elliott 803 computer, which is five foot six inches long and four foot eight inches high, compactly contains all the logical units and the core store. The control console is linked to this cabinet by a cable*

**Instruction code:** single address, two instructions per word. 64 functions in eight groups of eight.

**B-modification:** any location in the store may be used as a B-modifier, under the control of a single B-digit in the instruction pair. This operation takes no extra time.

**Checking facilities:** all transfers to and from the store are automatically checked by means of a stored parity digit.

**Representation of numbers:** binary, in the range of -1 to +1, negative numbers being represented as the complement with respect to 2.

**Power requirements:** 240v. Single phase, approximately 0.5 kVA.

## 2—A Visible Record Computer

**B**URROUGHS Adding Machine Limited recently announced a high speed solid-state computer, the B251 Visible Record Computer.

This machine is specifically designed for the banking industry, to handle the largest data processing problem in the world. While the system will have other applications, the company's marketing plans call for concentrating first on banking needs.

It is named the Visible Record Computer because it selects and writes directly on individual account records. The computer, the first of its kind to be announced, reads information directly from cheques, deposit slips and other documents of varying thicknesses and sizes, processes the

information and automatically computes, selects and posts directly to the correct customers' account record.

The newly developed technique eliminates costly intermediate steps of transferring information to punched cards or magnetic tapes.

The system utilises magnetic ink characters that can be read by electronics as well as by people.

Merging highspeed electronic computation, advanced magnetic techniques and automatic handling of accounting forms, the system will automatically perform all the work in a bank's bookkeeping and statistical analysis departments, including cheque handling, proving, bookkeeping and preparation of customers' statements and bank records.

The flexibility of the system will permit banks to use it for current accounts, savings accounts and loan accounting operations. It will also provide accounting and statistical reports vital to bank management.

Four units comprise the system. The first is the world's fastest sorter, a solid-state device which was announced by Burroughs last March. This machine sorts and reads cheques, deposit slips and other bank documents through the means of the magnetic ink characters printed on these items, including the account number, amount and other information.

The second unit is the computer, a completely transistorised machine with a magnetic core memory. The computer processes the information read by the sorter and sends it to the third unit, the record processor. Here items are automatically posted on ledger and statement forms, proved, and the customer's current balance computed and printed.

The Visible Record Computer is controlled from a console, fourth unit of the system. It consists of programme selector knobs, special controls, a panel of lights that displays the status of the computer, and a keyboard which permits entry of unusual items.

Instructions can be given for the system to reject cheques on which stop payment orders have been placed and refuse payment of cheques if an account is overdrawn. It can also accomplish balance transfers, compute and post service charges and statistical information, and accumulate trial balances all at the same time.

As a by-product of processing operations, the computer system will provide accounting and statistical data needed for management decisions, including reports on inactive, overdrawn and closed accounts as well as significant balance changes.

### ELECTRONIC STRIPES

Individual account information printed in standard type on the face of each ledger is also stored electronically in two narrow magnetic stripes on the back of the form. This enables the machine to read the ledger as well as carry out special instructions, also stored in the stripes, relating to the account.

The stripes perform the same function as magnetic tape used by other computers for input and storage of data. They will contain such information as account number, balance, account activity, cheque and deposit counts and numerous computer commands.

Computer programmes are stored on long-lasting Mylar plastic tapes which are easily installed on tape readers in the control unit. The system may use up to 12 tape readers, permitting more than 2,500 programming instructions at any one time. A library of standard programmes will be available for instant use.

Storage of programmes and individual account information on Mylar tapes and magnetic ledger stripes leaves the core memory of the computer free



*The compact modern design of the Burroughs B251 visible record computer shows the results of advanced production and design techniques. Completely solid-state, the computer has over 4,400 transistors and magnetic core memory. All four units of the system are seen here—1: the sorter in the left background; 2: the computer cabinet in the right background; 3: the processor in the centre; and 4: the control console in the foreground*

*Programmes for the B251 VRC electronic data processing system are stored on long-lasting Mylar plastic tapes, seen here, held by the engineer (left hand). Installed on tape readers, seen in the cabinet at the rear, the system may use up to 12 tape readers, permitting more than 2,500 programming instructions at any one time. Through this method, a library of standard programmes is ready for instant use. The small transistorised printed circuit board held by the engineer (right hand) indicates how miniaturisation has been used to make the entire system compact and rugged. Rows of similar circuits are seen in the lower cabinet*





*With the side panel off, the interior of the processor of the B251 electronic data processing system shows the record carrying train and the location of the ingoing and outgoing ledgers. This unit, one of the four components in the system, prints standard type on the face of each account and stores the information electronically in two narrow magnetic ink stripes on the back of the form. This enables the machine to read the account as well as to carry out any special instructions*

for the intermediate storage of data, totals and constants needed for arithmetic functions.

The system will utilise advanced new memory core packets, each with a capacity for storing 10 computer words. This will permit a bank to tailor the capacity of the computer to its individual needs, saving the expense of buying core memories

that will not be used. As a bank's requirements grow, the core memory capacity can be increased simply by inserting additional packets into the computer.

The system is capable of performing 4,000 arithmetical functions a minute and operates directly in sterling.

### 3—Short's Multi-purpose Machine

**S**HORT Brothers & Harland Limited are about to market a large multi-unit analogue computer of entirely new design. A quarter-scale model of this instrument, together with some of its components, was on display at the company's computer stand at Farnborough.

The new computer has been specially designed to deal with the problems of modern science and incorporates all the automatic aids necessary to ease the handling of complicated problems, including nuclear kinetics. Short's computer design staff have developed new wiring techniques, in which the printed circuit system has been much extended, and a revolutionary patching system which eliminates cord clutter. All these features combine to give a component accuracy of better than 0.01 percent.

The basic instrument is a 112-amplifier linear computer, but it has been so designed that the specific requirements of an individual customer can easily be met merely by plugging the specified components into the standard racks. Up to nine special non-linear components can also be incorporated if desired.

The computer consists of seven standard racks, the three control racks being confronted by a

double pedestal desk. The transistorised power units are located below desk level and the measuring equipment and non-linear components (if any) above desk level.

The twin racks on each side of the desk are identical in construction and contain the computing elements; interconnection of the elements is effected by two patch panels set into the desk top. These twin racks are of modular construction, there being 56 modules per rack, and each twin unit consists of one rack of amplifiers and one rack of passive elements.

Each of the racks containing the passive elements is a double walled temperature stabilised oven, the inner enclosure being maintained at a constant temperature plus or minus 0.5 degrees Centigrade. The amplifier units are of new design, having a main amplifier gain greater than 105 and a drift over 24 hours at unity gain better than 10 microvolts. (Drift correction factor 1,000.)

All computing units, including those of the temperature-stabilised elements, are removable from the front for ease of maintenance.

One of the most noteworthy features of the design is the patch panel by which the active and passive outputs and inputs are interconnected.

**AUTOMATIC DATA PROCESSING**

The connections are made by single pin plugs and single patch cords. Although up to 20,000 different connections are possible and up to 100 cords may be employed per panel, none of the latter cross. This is one of the most important advances in computer design yet achieved and, as the cords are adjustable in length, there are no unsightly loops of cord to obscure the panel. The panel is fully screened and removable to facilitate the storage of problems.

A new design of selector panel enables any amplifier output to be connected to any of the measurement channels, or any of the servo-set potentiometers to be set-up from the control desk by means of selector buttons and setting keys.

Thirteen measurement channels are provided which, apart from the mandatory digital voltmeter, can be arranged to suit an individual customer's requirements. The digital voltmeter with its associated printer displays a four-digit fraction of 100 volts and is accurate to 0.01 percent.

The most comprehensive checking system yet devised for any computer ensures a rapid check of all circuits and connections, the sequence being automatically stopped if any errors are detected.

Although the capacity of the computer has been carefully planned to meet the demands of the present-day mathematician, where necessary it can be extended by twin-rack units identical with the main racks. The extension units may contain up to 56 active and 56 passive modules and extension patch panels are provided. These are connected



*An artist's impression of the new analogue computer developed by Shorts. The makers claim it to be the most advanced of its kind in the world. The prototype is now being built and production models are scheduled for 1960*

to the main patch panel by 50 bus-bars. The selector panel on the main control desk is used and it can handle up to four extension units. Modifications can be made permitting the addition of more than four extension units if required.

It will be evident that Short's new computer is not a mere enlargement of their existing general purpose computer. The computer is new in thought, design, wiring technique and ease of operation.

#### 4—Solartron's New Analogue Computer

**T**HE new Solartron analogue computer, Space 30, sets an entirely new standard for versatility and operating efficiency in the analogue computer field.

The direct result of an extensive survey of industrial user requirements, Space 30 is the first computer of its type to be made commercially available in desk console form.

It combines excellent work-load capacity with a high degree of accuracy. Its 30 operational amplifiers are fully equivalent in problem-handling capacity to that offered by computers using 40 or more amplifiers.

Space 30 has outstanding operational flexibility. Ideally suited to the requirements of modern industry, the computer has been designed on modular principles to allow for simple modification or expansion.

The applications of Space 30 are extremely wide. It will provide accurate solutions to a wide range of linear and non-linear dynamic problems. Its comprehensive control facilities, inherent flexibility and automatic programming facilities make it particularly suitable for use as a simulator of all types of automatic servo control systems, including

the electrical, mechanical, hydraulic and pneumatic, in industrial and military fields, nuclear reactor kinetics, and the investigation of aerodynamic, hydrodynamic and thermodynamic systems. It is recommended by the makers for the analysis of industrial process control systems and for the study of heat transfer problems, vehicle suspension systems and the investigation of the problems of vibration and structural stability.

Operation is easy and comfortable. The control, monitoring and programming facilities and all passive networks are contained in a temperature-equalised unit mounted above the desk surface.

##### SPECIAL TECHNICAL FEATURES

A central detachable problem board (816-way) allows problem storage and simple patching, with many connections using two-pin links when they continually recur, thus avoiding 'clutter'. Problems may be prepared away from the computer itself.

The five-digit digital voltmeter (0.01 percent accuracy) enables coefficient potentiometers, initial conditions and function generators to be speedily and accurately set up and, also, supplies and

computing junctions to be instantly monitored to 0.1 per cent accuracy.

The unusually comprehensive passive networks and amplifier control circuits incorporate resistors and capacitors which are highly stable and of 0.1 percent accuracy.

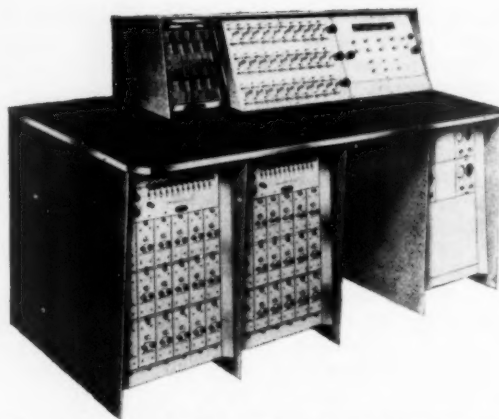
The over-all computing accuracy is enhanced by the system  $\pm 100V$  reference supply, which has a long-term relative accuracy of  $\pm 0.005$  percent. Alternative computing components for special purposes may readily be applied to any of six amplifiers individually, or any group of five amplifiers. This ensures the maximum utilisation of available capacity.

Space 30 includes in its complement of computing units four servo multipliers, two diode function generators and other non-linear elements, which allow specific problem non-linearities to be accurately set-in to it.

A high-accuracy automatic timing device using a DC amplifier is included for operating the computer under controlled recycling conditions. This is of particular use and importance in, for example, the exploratory analysis and evaluation of a problem whilst the system parameters are progressively changed.

Any part of the computer can be in the 'reset' condition while the other part is computing, and when some pre-determined time or amplitude level has been reached the 'inverse reset' line can be energised, so switching the remainder of the machine into 'compute'. Thus the first part of the computation can be used to establish the initial conditions of the remainder.

Problem check and scaling facilities are incorporated for positive problem verification and for the speedy checking of the fully programmed computer. Manual or automatic decade scale



*The new Solartron Space 30 analogue computer, say the manufacturers, 'sets a new standard for efficiency, flexibility and value.' An artist's impression of the finished product*

factor changes may be programmed for the whole or any part of the computer.

Space 30 is contained in a desk unit 80 inches long, 36 inches high and 38 inches deep, with the control unit 60 inches long and of maximum (front edge) height of 12 inches above the desk surface.

The price of a complete Space 30 analogue computer is £10,500.

The first two production models have been ordered by the British Thomson-Houston Company at Rugby. They will be used in the analysis of complex control problems encountered in the application of electric motors and controls to a wide range of industrial requirements, including pit-head winding gear, printing presses, textile and paper manufacture.

#### **'COMPUTERS FOR THE SMALLER FIRM'**

A one-day Conference, organised by the Central London Productivity Association, to be held on Thursday, October 22, 1959, from 9.45 pm until 4.45 pm at the Council Chambers FBI, 21 Tothill Street, London, SW1.

This Conference is designed solely to introduce the smaller firm to the potentials offered by computers; to illustrate the use of the smaller computers; the progressive utilisation of computers; service centres, joint ownership.

Speakers from three leading computer manufacturers will be illustrating their papers with slides and case histories. Two other speakers will give information on computer centres, and user experience.

There will be ample opportunity for questions during the latter part of the Conference.

The Conference fee will be 45s (members of the Association 35s), to include coffee, luncheon and tea.

Programmes and tickets may be obtained from Mr D MacGlashan, Central London Productivity Association, c/o Stafford Allen & Sons Ltd, 20-42 Wharf Road, London, N1.

Machines that will read handwriting or typescripts or that will type out immediately the spoken word caught the imagination long before scientists tried their hand at designing them. When they did, they encountered two problems basic to developing both types of machines; first, that of breaking up scripts or broken words into patterns and secondly, producing machines to recognise and record infallibly these patterns. The first problem was easier to solve, and some considerable advances have been made in resolving the second.

# THE SEARCH FOR PATTERNS AND RECOGNITION

by RICHARD FATEHCHAND

**A** FIELD in which digital computers are likely to play an increasingly important part is that of 'pattern recognition.' We would like, for example, to control a machine by feeding typed or handwritten instructions into it, or by speaking into a microphone. The difficulty in doing this may be illustrated by considering the recognition of the letter 'A.' It must be distinguished from the other letters of the alphabet even though it may be typed as a small letter or capital, and may be mutilated.

A paper presented at a recent meeting on digital-computer techniques at the Institution of Electrical Engineers indicates that a group at Manchester University have attacked this problem with considerable success. The letter is scanned electronically by a method similar to that used in television, the scanner output being used as computer input data. Standard letters are first presented to the scanner, and these letters are analysed by the computer for certain features. These features are obtained by breaking the letters

into straight and curved segments, which are measured for shape, curvature and relative length. The results of the analysis are independent of the size and orientation of the symbol, an obviously important point.

The features relevant to characters 'A,' 'B,' etc are stored as a 'library' in the computer. When an unknown letter is presented to the scanner, its features are analysed as stated, and it is 'recognised' as the member of the 'library' with which it has the most features in common. If the unknown letter is distorted so that it is intermediate in properties between two members of the 'library,' the machine will state the probability of either letter having occurred.

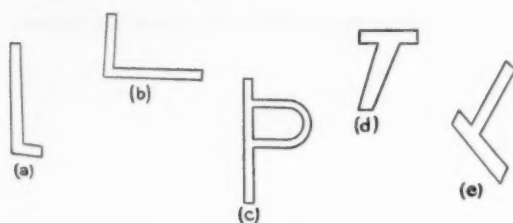


Fig. 1

The 'recognition' flexibility of this machine is illustrated by its behaviour when the characters in Fig. 1 are presented to the scanner. Letters (a) and (b) are recognised as 'L,' (c) as 'P' and (d) as 'T.' The last letter might be either an 'L' or 'T,' and the machine indicates that such an uncertainty exists. It is likely that this computer recognition method can be extended to deal with handwriting. In this case, scripts vary so widely that the computer will have to make use of the context of each character as an aid to recognition. This can be done in principle.

### Making sense of words

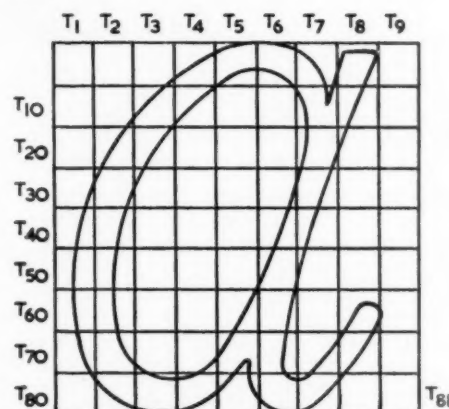
The problem of 'pattern recognition' in speech is a much more difficult one than the foregoing, but a start has been made along similar lines. Here it is necessary for the machine to 'recognise' the flow of sound at least as a succession of discrete words.

It would be even better if the words could be further broken down into the elementary speech sounds, for example the sound 'bat' as b-a-t. If this could be done, 'speech typewriters' could be constructed. The problems are formidable, however, since different speakers vary in pronunciation, and pronounce the 'same' sound differently in different contexts.

Despite these problems, an American group at the Lincoln Laboratory of MIT has obtained promising results. These results were presented in Paris at the UNESCO Conference on Information Processing held last June.

The speech must first be converted into a form suitable for computer input. Since the complex speech wave is made up of a large number of

Fig. 1



One example of recent work in character recognition is that of Dr K W Taylor, who heads the Electrical Engineering Section of the Nuffield Foundation Cerebral Mechanisms Research Unit at University College, London.

As an offshoot of research work on brain mechanisms and learning processes, Dr Taylor invented an apparatus capable of reading or recognising simple patterns or silhouettes such as alphabetical characters, numbers, etc.

The machine was designed so that its 'memory' could be conditioned—in other words, so that it could 'learn' to recognise any desired pattern by 'showing' the apparatus a new pattern for a short period.

The apparatus comprises a matrix of transducers, such as photocells, followed by a device referred to as a *detail filter*. This serves to enhance any discontinuities in the presented patterns and to eliminate 'background noise.' Suitable different combinations of the outputs of the detail filter, corresponding to different characters to be recognised, are fed to a set of parallel amplifiers so connected that an output is available only from that amplifier which corresponds to the pattern or character being projected. This output can be used to operate any suitable device which indicates the required character.

First improvements to the machine gave greater efficiency to the detail filter device with an interconnected matrix of resistors and amplifiers; also by utilising printed circuit techniques, an improved method of manufacture was evolved. A further development was to replace the initial transducers

### AUTOMATIC DATA PROCESSING

components which differ in their frequencies, these components are separated by means of filters. The filter outputs are sampled periodically (ie scanned), the samples being fed to the computer. It will be seen that this method is basically the same as that used for printed characters. As before, the data are analysed for suitable discriminating features.

It has been found possible to devise a computer programme which detects whether the speech sound is a vowel, a 'fricative' (sound such as 's') or a 'plosive' (sound such as 'p'), and which indicates when a silent interval is present. This information is printed out by the machine. If the sound is a vowel, it is classified into one of three groups.

*Continued*

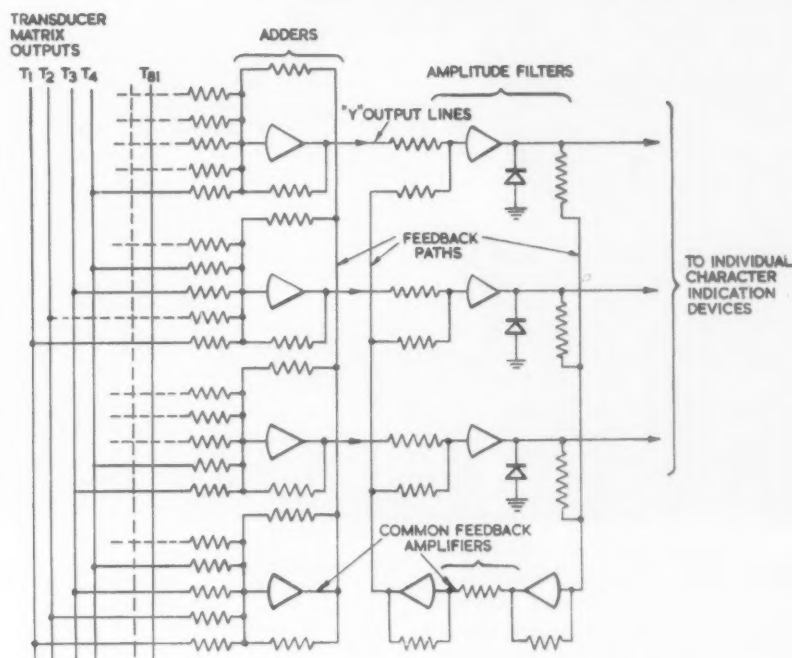


Fig. 2

and detail filter systems by video wave forms such as are produced by a television camera.

In its original form the apparatus required a very large number of components to recognise all possible patterns, because of the complexity of interconnexions of the transducer elements. Consequently, Dr Taylor produced a simplified design for apparatus suitable for use in reading alpha-numerica characters both of handwritten forms such as signatures, and printed forms.

With this system an image to be recognised—such as that in Figure 1—is presented to a matrix of 81 transducers. Selected combinations of outputs from individual transducers, one set for each character to be recognised, are fed to individual adders to produce what is called a 'Y' output for each set.

The selection of transducers contributing to any given set and the methods of adding the numbers of that set are made according to a mathematical formula such that the 'Y' output produced on

the presentation of a given character is the largest possible for that character and is greater than that of any other sets, even though many of the elements may be common to several sets.

In general any character presented will produce some 'Y' output on all output lines, but the particular output corresponding to the presented character will be the largest. All these 'Y' output are fed to individual parallel feedback amplifiers which ensures an output from that amplifier only which has the largest input. This unique output signal can then be used to operate any device indicative of the character being recognised—for example it may control the pulsed binary coded equivalent of the character enabling the machine to act as a direct input to a computer.

A semi-schematic diagram of the simplified apparatus is shown in Figure 2.

A fuller account of Dr Taylor's inventions together with references to patents applied for appeared in *Bulletin No. 14*, published by the National Research Development Corporation.



EMI's figure reading device, Fred, marks one stage in the endeavour to produce machines that can read hieroglyphics. This device can read figures at high speed, though these have to be expressed in a special, stylised type.

Although the output information is insufficient to discriminate English words in general, it has practical application if only a restricted number of different spoken words are permitted. For example, there is the interesting possibility that a voice-operated device could be built which would enable a computer to be given oral instructions such as 'start,' 'send,' 'cease,' 'add up,' etc.

The reader might nevertheless be rather puzzled as to the value of this work. For example, a 'speech typewriter' which involved the use of a computer would not be a very practical proposition. The great advantage of a computer in this field is that its flexibility enables a variety of methods of 'pattern recognition' to be tested quite rapidly. When a practical solution is found, a simpler machine which only incorporates the necessary recognition processes can be built.

### CONTRIBUTIONS

The editor invites authoritative and thoughtful contributions on all aspects of automatic data processing. Factual accounts of first-hand experience in planning, installing and operating computer systems are particularly invited; but theories and prognostications based on practical experience in commerce, industry and government are also welcome.

Articles, preferably between 2,000 and 3,000 words in length, are most acceptable when typed with double spaced lines on plain quarto paper. They should be addressed to:

The Editor  
AUTOMATIC DATA PROCESSING  
Mercury House, 109-119 Waterloo Road  
London, SE1

AUTOMATIC DATA PROCESSING



James W. Perry, Director of the Center for Documentation and Communication Research at Western Reserve University, who invented the GE-250 document searching selector, was Chairman of the Machine Literature Searching session of the conference.

*International Conference on*

# Information Retrieval and Machine Translation

By ANDREW D BOOTH DSc, PhD

The author was one of the delegates to the conference sponsored by Western Reserve University and the Rand Development Corporation at Cleveland, Ohio, USA, and was Chairman of the Machine Translation session.

THE possibility of the establishment of a world scientific document centre was suggested during March of this year, with the announcement by Western Reserve University, Cleveland, Ohio, that the General Electric Company would build a high-speed prototype of the WRU searching selector called the GE-250. This device was invented by James W. Perry, director of the Western Reserve University Center for Documentation and Communication Research, and Allen Kent, in collaboration with Jesse H. Shera, Dean of the School of Library Science.

It is stated that the prototype will be able to search the entire scientific literature, assumed for this purpose to consist of 10 million abstracts, in 112½ hours. The GE-250 is designed to allow automatic reviewing and comparing, at very high speed, of extensive files of information to deter-

mine which piece of information answers in whole or part a specific enquiry.

## **LIBRARY REVOLUTION**

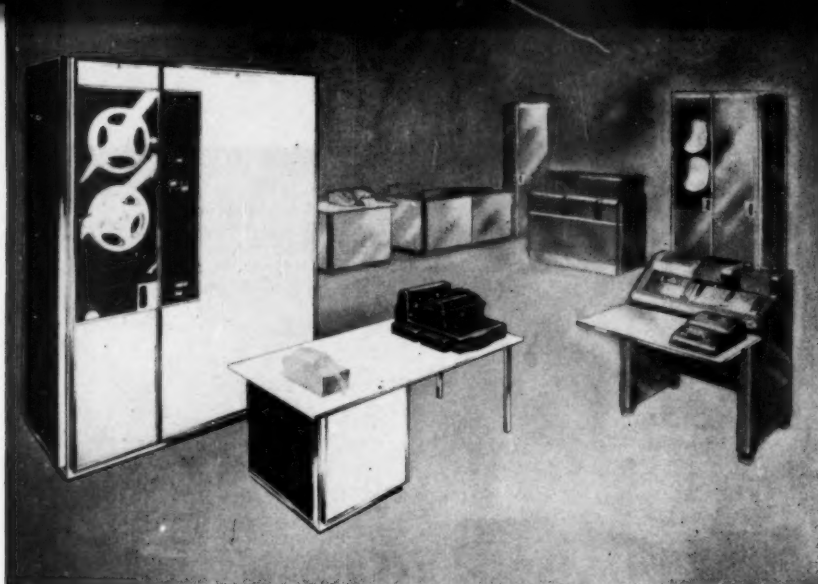
Commenting on the new machine, Dr. Shera believes that 'it could revolutionise the field of librarianship and library education as much as computers have revolutionised accounting.'

Describing it in more popular terms, Kent said that the GE-250 would 'search the entire 1037 pages of *Gone with the Wind* in three and a half minutes, picking out the number of times a word appeared or a combination of words which appeared.'

Kent returned from a trip to Russia in March, where he visited the Soviet Union scientific information centre. From his observations on that trip he believes that the acquisition of the GE-250 will put the United States back in the running with the USSR in regard to the mastery of scientific and technical information.

## **INDUSTRIAL VALUE**

Perhaps more significant for industry, the new machine will be able to search the year's output of the world's metallurgical literature in six minutes, the year's chemical literature in one hour, or an



*A perspective drawing of the GE-250 high-speed prototype of the searching selector, which is expected to be 'operational' in February.*

entire collection of company reports in several minutes, and will complement the work of large computers by providing processed data for management decisions. This has been proved by a three-year experimental project conducted by WRU's Center for Documentation and Communication Research for the American Society for Metals.

Since the beginning of this year, the WRU documentation centre has been keeping ten business organizations up to date on the most scientific happenings in their respective fields as a service of ASM by means of a prototype, relay, searching machine. With the increased abilities of the new high-speed machine, WRU will aid ASM offering this service to all of its 30,000 members.

#### **CLEVELAND CONFERENCE**

Descriptions of the new machine and discussions on the improvement of technical information processing formed a part of the work of an international conference on machine searching and translation held from the sixth to the twelfth of September in Cleveland, Ohio, under the co-sponsorship of Western Reserve University and the Rand Development Corporation.

The conference brought together leading information processing system specialists and designers from all over the world, including the Soviet Union. Some of the delegates were: Robert Watson, Commissioner, US Patent Office; Admiral George Frederick Hussey, Jr, Managing Director, American Standards Association; E I Levin, State Scientific Committee to Council

of Ministers, USSR; I S Mukhin, Assistant Director, Institute of Precision Mechanics and Applied Techniques, USSR; A D Booth, Director, Department of Numerical Automation, Birkbeck College, University of London; S R Ranganthan, Vikram University, Bangalore, India; and J Dekker, Netherlands Patent Office, The Hague, Holland.

#### **COMMITTEE APPOINTED**

The primary purpose of this conference was to encourage the development of a common machine language or a series of compatible machine languages to prepare scientific and technical literature for searching, selecting, correlating and translating by automatic equipment, but, as might have been expected, this extensive objective was not realised. Instead, a more modest conclusion was reached in which it was decided to set up an *ad hoc* committee which would continue the work of the conference, particularly by collecting and circulating lists of equivalent technical terms in the field, or by examining the possibility of exchanging workers in the field between the Eastern and Western blocs. This is particularly important because some scepticism was expressed at the wide claims which were made in some of the Soviet papers. These claims were quite unsupported by adequate technical reports and, although the large teams of workers who are involved could possibly have achieved the position claimed in the time available, it is not clear that they have, in fact, done so. An exchange of research workers in this field, which is not subject to security restrictions, might do much to foster international amity.

#### **AUTOMATIC DATA PROCESSING**

# Getting to Know the Drill

from a Special Correspondent

*Research is being conducted at Birmingham University into human skills employed in operating certain drilling machines which have not yet been successfully transferred to automatic control*

**R** ESEARCH workers at Birmingham University are trying to discover what may be termed 'the missing factors' in their knowledge of human skills involved in machine operation. If these skills, which enable an operator to carry out certain jobs which are not yet done satisfactorily by an automatic machine, can be located, it is felt that sensing devices for these impulses can be built into machine tools, particularly in-line transfer machines and digital computers used for controlling automatic machines.

In fact, they might be of great value in the programming of digital computers, because these machines, with their great stock of programmes, could be made to give greater flexibility to automation.

## **HUMAN 'PROGRAMMES'**

An analogy might be drawn between computers and the brain of the human operator, as the latter intuitively switches from one 'programme' to

another to suit the conditions of the task. If these human 'programmes' can be identified it is believed it would be a simple matter to build them into machines.\*

The studies are being made by the Department of Engineering Production as part of a programme that has been going on for some years, in which the Department has investigated skills in assembly processes and has given considerable attention to the training for skill. This section of the programme is concerned with the study of human aspects of machine control, and it is believed to be unique as a piece of research.

## **NO CONCLUSIONS YET**

The research workers are mainly concerned with pure research and it would be a matter for machine designers to take advantage of any results that may come out of it, although the Department

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\* See 'Digital Computers and the Brain' in *Automatic Data Processing*, Volume 1, Numbers 7 and 8, the issue for August and September, 1959.

does carry its research into the fields of practical applications. So far the Department has reached no firm conclusions, but has a number of hypotheses which are being examined. It is hoped to publish a report next spring.

### **BREAKING DRILLS**

The basis of the problem is the difficulty some firms have had in applying automation to certain tasks. They have included certain drilling operations which have resulted in frequent drill breakages, interruptions in the operation of expensive machinery and damage to components following drill breakages. Breakages have been as high as six times more than when the drills have been controlled by the human operator.

Often the processes involved have been the deep drilling of various materials and frequently they have been of a very small diameter hole, but difficulty has also been experienced in applying automatic machines to drilling holes up to 5/16th inch diameter.

Unsuccessful applications of automatic machines have included the following examples:

- (1) The drilling of an extremely small (No 56) hole in stampings;
- (2) Drilling of oblique holes in cast iron;
- (3) The drilling of holes in case-hardened material. Usually the metal is soft in the drill-hole positions, but occasionally it may be hard. With automatic machines this has resulted in drill breakages, whereas a human operator can sense the hardness and work accordingly;
- (4) Drilling of oblique holes in carbon steel.

After unsuccessful attempts to mechanise these jobs they have frequently been returned to girl operators, who have carried out the work rapidly and with only a fraction of the tool replacements needed when automatic machines were used.

### **HUMAN SKILLS NOT YET LOCATED**

Professor N A Dudley, head of the Department of Engineering Production, concluded that there must be some human skills that had not been located. The human operator engaged in drilling has only a limited number of things he can do. The question was whether the operator was able to gauge better the speed and pressure of drills, or whether he listens, consciously or unconsciously, for tell-tale noises which tell him it is time to readjust pressure or speed. Alternatively

the secret may lie in being able to keep an eye on the operation. Or the muscles in the arm may guide the operator as to what pressures to apply and about working speeds.

To enlarge on one of these possibilities, it may be the sound of the machine motor the operator is using. He may have a pre-conceived idea of a suitable drilling speed. Thus, when a drill commences, it initially runs 'free.' Then the operator decides, by training, the speed he wants to keep the drill going smoothly. When he reaches a hard spot in the metal or if, for any other reason, the drill slows down, the operator readjusts the pressure to return to the original speed and pass through the difficult patch. On reaching the termination of the hole, he probably changes his method and controls the tool so as to compensate for the lack of a solid base as the drill 'breaks through.' Exactly which senses are used to judge the various changes in the operation—and when they are made—is the subject of the University studies.

Mr E N Corlett, a research fellow who is engaged on the project, has spent a great deal of time reading up all the material he could obtain on drilling problems. Among the wealth of material on drilling there did not appear to be much on this specific problem.

### **'THE BIRD CAGE'**

The experimental apparatus erected in a corner of the department is nicknamed 'The Bird Cage' because it is enclosed in a wire cage to obviate electrical interference from existing fittings in the building. In the early stages of the experiments it was found that there was 50-cycle interference from the room lighting. The apparatus has also been carefully earthed.

It consists of a general purpose pillar drill, linked to an electro-myographical recorder which amplifies muscle movements of the operator. A six-channel galvanometer is used to record on a graph the rpm of the drill, handle pressure, displacement of the drill spindle, torque and the movements of the muscles. Over 500 feet of graph have been recorded and studied for variations in individual experiments in which the operator has worked normally, been blindfolded to test how much the eyes are the important sense, or worked wearing headphones through which a high-pitched note is transmitted from an oscillator to remove the 'hearing sense.'

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*Continued on page 50*

**AUTOMATIC DATA PROCESSING**

### A COMPUTER TRIAD

A J Leiner, W A Notz, J L Smith and A Weinberger:

**PILOT—a New Multiple Computer System**  
**Journal of the Association for Computing Machinery, July 1959, Vol 6 No 3 (USA)**

PILOT is a high-speed multiple computer system, designed as an experimental tool to investigate large-scale problems of business data processing. The authors are officers of the National Bureau of Standards, Washington, DC, USA.

As Pilot may have to simulate characteristics of many kinds of data processors, the logical design had to provide for a highly flexible system, capable of operating with diverse external devices. The system can also be extended to investigate problems in scientific computation, language translation, automatic control of electrical and mechanical instruments and automatic communication with other data-processing systems.

One of the problems to be explored for the United States government will be the control of aircraft traffic, in conjunction with radar and other flight-control equipment. 'The system is flexible enough and fast enough to accept, with little or no advance notice, a random flow of incoming information about events occurring in the outside world; and the system can automatically cause the internal program to respond appropriately to the external situation.'

Pilot contains three independent computers which can work concurrently on a common problem—a model of an automatic multi-computer network. Each of the three computers carries out a different function. 'The primary computer is a high-speed general-purpose machine that carries out most of the high-precision arithmetic and logical processing operations. The smaller second computer acts as its partner . . . Acting as a team, both computers can carry out special complex sorting or search operations. The third computer works on data that is flowing into or out of the system to or from the peripheral external units.'

The three computers can communicate concurrently with the internal memory. The third computer acts as a kind of traffic controller to route these demands on the memory.

**The Role of Electronic Communications in Business Automation**  
**Management and Business Automation, August 1959, Vol 2 No 2 (USA)**

THE August issue of *Management and Business Automation* was devoted to articles on various methods of communication and data transmission. 'Applications range from nation-wide networks transmitting data for centralised computer operations to the simple, but effective, intra-plant installations.'

The use of wire networks, especially with teleprinter equipment punching tape from remote sources, is rapidly spreading in the United States. The bulk of direct wire facilities is provided by A T & T (63 million miles) and Western Union (three million miles), including a network over 250,000 miles for the US Air Force. Airlines have made extensive use of line and punched cards to control the reservations problem.

Microwave radio links, closed-circuit television and two-way radio telephones are other systems reported on in this special issue.

**P C Lutz:**

**The Place of the Consultant**  
**Punched Card Data Processing, July/August 1959**  
**Vol 1 No 5 (USA)**

THE consultant is proving his value in the modern business world. The place of a consulting firm can be likened to that of a family doctor. You don't keep a doctor in the house at all times, but you go to him when you are ill and he prescribes a remedy.

Some of the ailments that consultants are called on to solve are: where production and sales have outstripped the company's capacity to keep up with effective clerical procedures; where improvement of clerical functions is a necessity but internal management has not time to deal properly with the problem; where there is need for vast technical knowledge but over a limited period of time which would not justify employing a full-time specialist; where office mechanisation has been undertaken with insufficient preparation; and wherever it is important to have a completely independent, unbiased approach to an internal company problem.

# A System of Control for Retail Stocks

**T**HE Kimball system of data processing is based on the Kimball automatic data processing price ticket, which introduces a new concept of the function of a price tag.

First, what does the Kimball system achieve? In the main, it brings facts into the control system faster and more accurately than any other means.

Control is a matter of facts that are sufficiently topical for corrective action to influence situations as they develop. In this influential rôle the Kimball data processing ticket enables retail stores, for example, to receive facts about daily merchandising operations in a form which can be fed automatically into any punched card system.

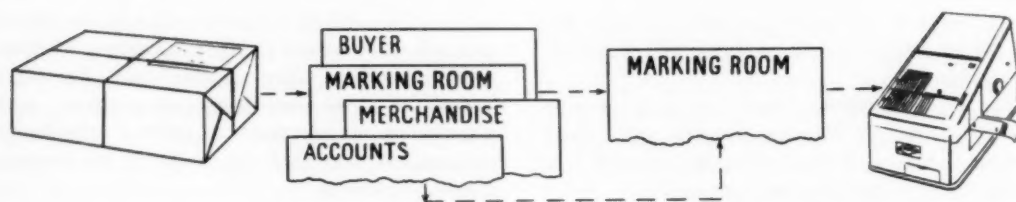
## DAILY ANALYSES

In the United States, where the Kimball system has been quite extensively used, numerous firms' analyses of each day's sales are presented regularly at nine o'clock the following morning. Such is the effect of this immediate knowledge of the movement of stocks that the majority of Kimball-equipped firms no longer need seasonal 'sales' to dispose of slow-selling lines, since the more exact control of stock allows them to be deployed elsewhere.

A few pioneer installations are already working satisfactorily in Britain with retail organisations. The system works smoothly with any of the well-known punched-card data processing systems and analysing equipment marketed by such firms as IBM and ICT.

## CHARACTERISTICS OF THE TICKET

The Kimball ticket, itself a punched card, carries all the information, in punched holes and normal printing, relating to the styles, sizes, prices and qualities of the stocks to which it is affixed. It provides a complete record that can travel and remain with the goods from the time they leave the factory or warehouse until the moment they are sold. Its information can be automatically read and presented for punched-card analysis,



AUTOMATIC DATA PROCESSING

eliminating the work of existing card punching and verifying operations. It can be attached to goods by any of the conventional methods, including stringing, pinning, sewing, stapling and pasting on. It provides a simple, attractive and clearly legible identification of the goods, with space for the name of the store retailing the articles.

#### MUTILATED TAGS USABLE

Fairly severe crumpling and similar mutilation can take place before the ticket is rendered incapable of processing. In fact, it is generally true to say that the only effective way to destroy the value of the data on the ticket is literally to tear out the punched portion of the ticket.

The original punched information on the ticket can be modified by further punching on a hand machine. Price changes can thus be recorded either at the warehouse or in the retail shop, in readiness for processing and analysis.

#### SUPERSEDES MANUAL SALES RECORDS

The Kimball system abolishes the laborious manual recording of sales abstracts, a vital job which hitherto has often been delegated to sales assistants, with attendant risks of inaccuracies through haste or the illegibility of the entries owing to the variable reliability of the assistants.

The tickets can be used singly, or in pairs, threes or fours. The number of identical tickets will, of course, be determined by the number of points at which it is desired to separate the data for processing.

The multiple tickets are perforated and will normally be severed by the punch-printing machine. The single ticket is approximately two inches high by one inch wide, on which 24, 36 or 48 columns of data can be punched. The ticket illustrated in the accompanying diagram has 36 columns of binary data, each column containing four holes.

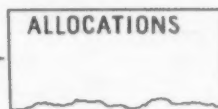
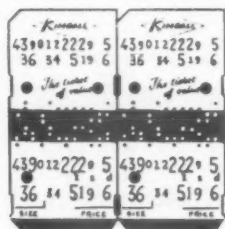


#### THE KIMBALL '75' PUNCH PRINTER

One well-known company already using the Kimball system, commenting on the '75' punch printer, said that, regardless of its data punching facilities, it more than earned its keep as an ordinary ticket pricing machine, simply because of its rapid slide set-up mechanism and of its speed of operation—over 10,000 tickets per hour.

It is a remarkably compact, precision-built machine with a choice of three type sizes. The machine, fitted with an auxiliary printing unit, can overprint tickets with such additional information as 'wool,' 'silk,' 'cotton,' etc. Interchangeable colour-stripping pens are also available, making a system of colour coding possible.

Twenty-four columns of binary code holes are punched in two rows of 12, and three large location holes are punched simultaneously. The location holes are used to feed and locate the ticket accurately for later machine reading, effective even on partially mutilated tickets.





#### SWEDA CASH REGISTER WITH KIMBALL TICKET PUNCHER

This machine enables the operator to punch into the Kimball ticket such information as the actual price charged for the individual item, the assistant's identification, for crediting commission on the sale, and for similar purposes. The ticket is taken from the article at the moment of sale and punched, after which it is retained in a locked compartment.

An alternative use is with credit accounts. Credit customers can be issued with books of tickets, and each purchase can be recorded on a ticket for processing and billing.

#### FLEXIBLE SYSTEM

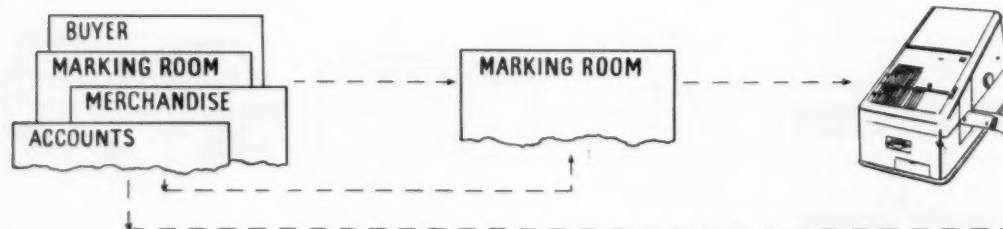
While it is obviously impossible to provide standard systems to suit the particular needs of individual retail organisations, the system is flexible enough to be adapted to provide a complete automatic data processing cycle from the beginning of retailing to final documentation for virtually any retail application.

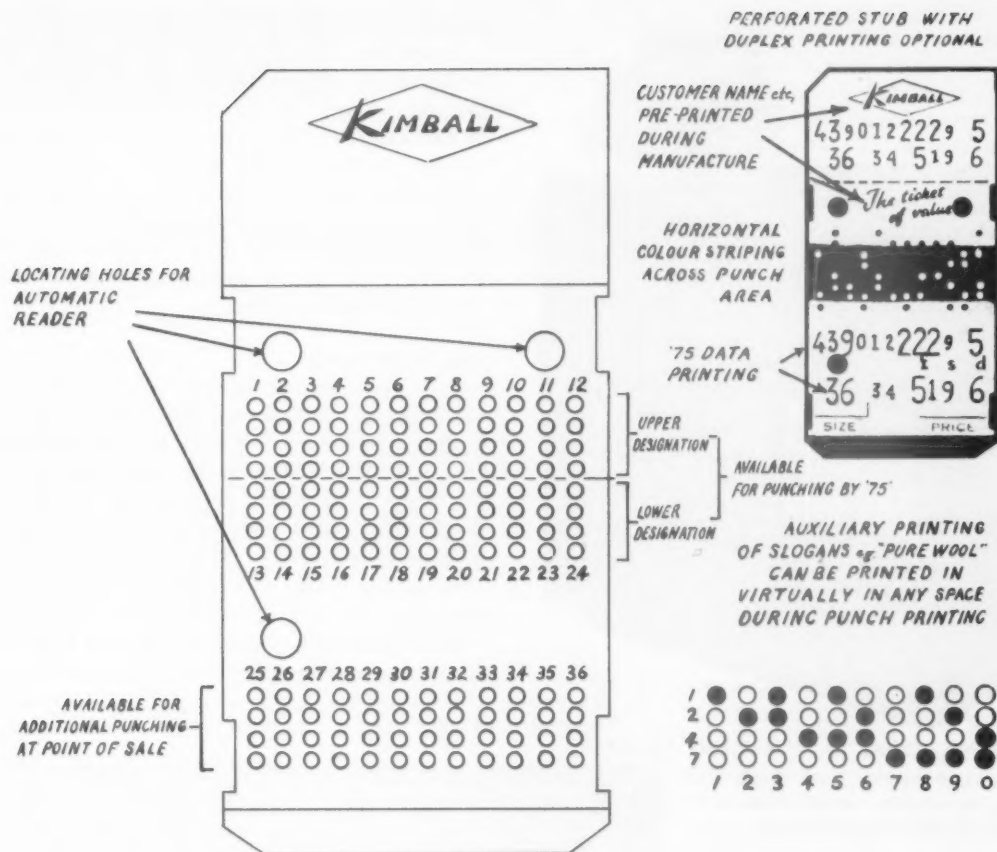
The basic system was devised for goods to which individual tickets were normally attached in the retail shop. In most cases these would be the more highly priced single items such as items of clothing. But there are many items of merchandise too small or of too low a value as individual items, to justify the fixing of a ticket to each piece. Also, there are many goods which are stocked in quantity and sold in variable amounts, curtain fabrics, tins of paint, zip fasteners or rolls of film, for example. For all kinds of items like these the Kimball system can be adapted to give sales information and stock control.

#### STOCKS SOLD BY WEIGHT

In the case of merchandise stores sold from bins or racks, usually in fixed location in the retail store, tickets can be prepared on the Kimball '75' punch-printer and kept in a container next to the merchandise to which they refer. As each sale is made an appropriate ticket is removed from the container and placed ready for despatch to the data processing centre at each day's end. In the case of goods sold in varying quantities, the quantity sold and the value can be punched in by means of a station punch in the retail store. Such a punch can be attached to a cash register and the ticket automatically perforated.

In many stores there are innumerable sundry items of merchandise of small value, but over which it is important to keep proper control. Such things as shoe laces and polishes, minor photographic accessories, soaps and toothpastes, etc.





#### THE KIMBALL TICKET

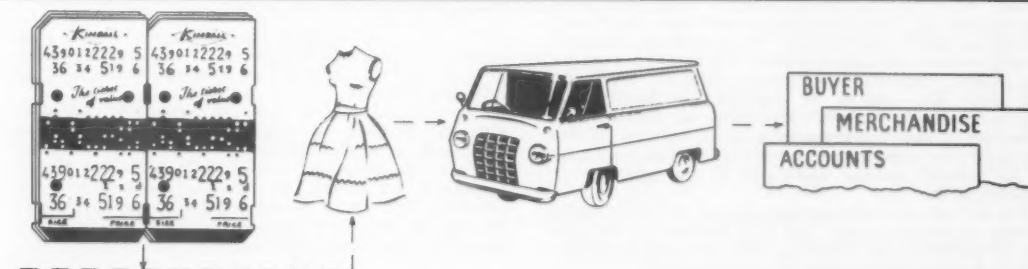
These items would be handled in much the same way as the bulk merchandise sold from bins.

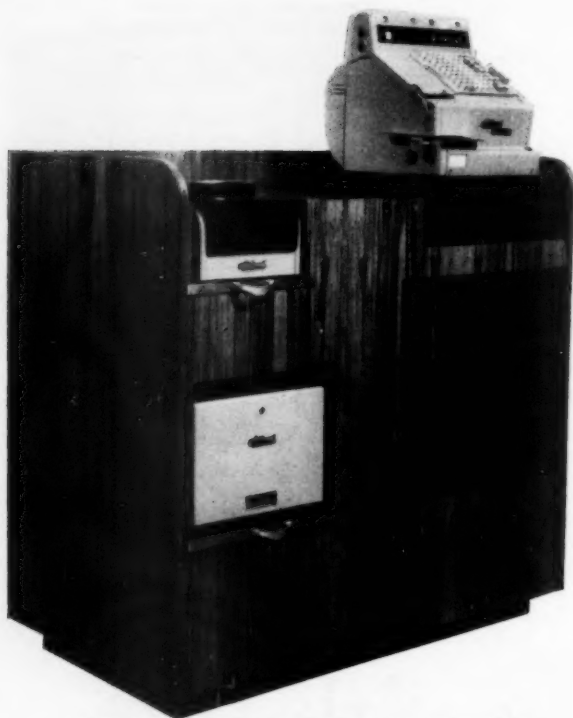
Diagram of an exploded ticket (left) shows the 36 columns available for punching in binary code.

#### INDIVIDUAL RETAIL ITEMS

In most cases, perhaps, the tickets will be individually attached to items like articles of clothing, where each sale is of sufficient value to warrant recording separately; and this may be regarded as the standard application of the Kimball ticket system.

There are two variants of the system: one in which the marking of the ticket is done by the retailer when he receives the goods and the invoice information, the other in which the goods are pre-ticketed by the manufacturer or the buyer for a chain of retail stores.





#### THE NATIONAL SALES-TRONIC REGISTER

This sales register, with media reader and automatic punched paper tape recorder, represents a major advance in the automation of departmental stores and shop accounting procedures

#### TICKET CODING BY RETAILER

In the first case, the goods will be despatched to the retailer with the relevant delivery notes and invoices. The goods will then be coded for details of manufacture, style, colour, size and price, the tickets punched on the Kimball '75' punch-printer and attached to the goods, which are then delivered to the appropriate department for sale. If a two-part ticket is used, one part may be detached at this stage for processing in branch and warehouse stock accounts.

#### PRE-TICKETING

The alternative method is by using a system of pre-ticketing. In this case the retailer, when he places a purchase order with the manufacturer, codes the data relating to the class, style, colour and price of the goods, prepares the tickets and sends them, with a copy of the purchase order, to the manufacturer. The manufacturer then attaches the tickets to the articles for sale and despatches the ticketed articles to the retailer.

Both systems are illustrated in the strip diagrams accompanying this article.

## BOOK REVIEW

**The Business Computer Symposium: Olympia, London, 1st to 3rd December, 1958.**

**Sir Isaac Pitman and Sons. 75s.**

THE 23 papers read at the British Computer Symposium, last year, are reprinted in this volume with verbatim reports of the discussions after each paper. This forms an extremely useful anthology of commercial and industrial applications and theory, even though there is wide variation in the merits of individual papers. It is a comment on the rapidity of advance in computer-using techniques and in thinking about the potential value of machines that some of the opinions expressed already have an outmoded flavour. Much has been learned, and no doubt many bitter tears have been shed, during the past twelve months; but most of the material in this volume retains its value. There have been so few entirely successful computer installations until now that these few tend to be described *ad nauseam* in articles and talks; but the convenience of this compact collection of case histories and prognostications for the comparatively experienced computer-user can be added to its possibly greater usefulness as an introductory volume for the tyro.

The various contributions together cover an extensive variety of computer uses. Mr N C Pollock, of Stewarts and Lloyds, describes the preparation for, and the installation and gradual loading of, the company's Leo II/3

computer, on which, at the time he read this paper, a part of the total payroll was being prepared and forecasting for the quarrying of iron ore was being worked out.

An application of computers to public utility accounting is described by Mr G Sherlock, of the South Western Gas Board; but this paper, like several others, was written when planning had been thoroughly carried out but before practical experience had been gained in the application described.

Other writers discuss the application of computers to inventory control (A Bradley, of Ford Motor Company), banking (L Temple), a social survey (M A Wright), insurance (K E Shang), sales statistics (C A Wilkes, of Imperial Chemical Industries), operational research (D G Owen, of United Steel Companies), and other information systems. Diagrams and charts are appended to most of the papers and enhance their value as reference material.

There is one subject which is, apparently, not dealt with at all except for a brief but inspired suggestion from Mr Derek Wragge Morley in the discussion following his paper on computing services: this is the use of data processing machinery to retrieve information from reference libraries. I would wager that this is likely to become the most important of all uses to which data processing machinery will be put in the next decade.

Erroll Wilmot

#### AUTOMATIC DATA PROCESSING

## Accessories

### New High-speed Memory

A HIGH-SPEED magnetic film memory is now in operation as part of the TX-2 digital computer at the MIT Lincoln Laboratory. Its performance has been entirely satisfactory since its installation in July, 1959. It has a capacity of 32 ten-bit words, suitable for evaluation testing, and serves as an experimental prototype for larger units. This new memory, and the TX-2 computer of which

it is a part, were developed by Lincoln Laboratory under Air Force contract, with the joint support of the US Army, Navy, and Air Force.

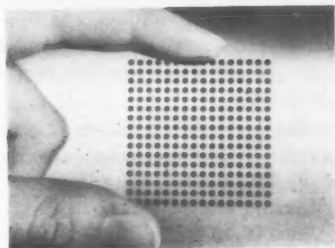
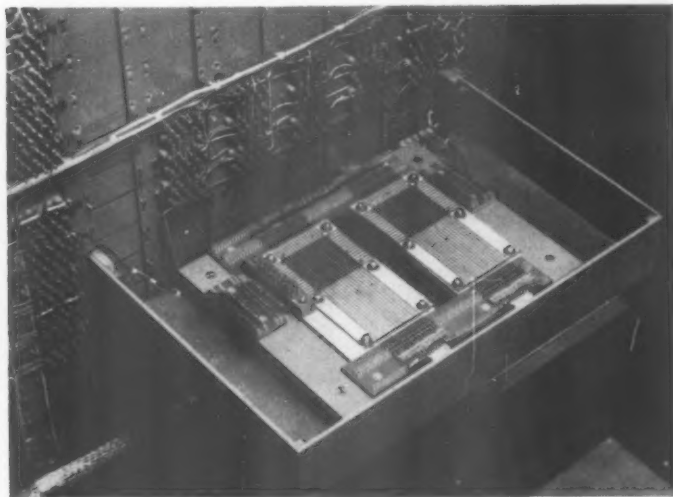
The read-and-write cycle time of 0.8 microseconds is consistent with the speed of the computer itself, although bench tests demonstrated successful operation at a cycle time as short as 0.4 microseconds. Net driving current for writing is 150

milliamperes, and one-millivolt output signals are obtained from individual memory elements.

Each memory element is a circular spot of Permalloy film (82 percent nickel, 18 percent iron) 750 Angstroms thick, 1.6 millimeters in diameter, centered 2.5 millimeters apart. The spots are deposited by evaporation on a flat glass substrate, 0.1 millimeter thick, in 16 x 16 unit arrays. The complete memory unit as installed in TX-2 and one of the experimental arrays are shown in the accompanying photographs. The transistor drive and sense circuits can be seen surrounding the memory.

A thin film memory has several potential advantages over the familiar ferrite toroidal core memory: faster cycle time, lower power dissipation, greater compactness, and simpler fabrication. The unit now in operation confirms these expectations, although none of these factors has been fully exploited in this first development model.

*Massachusetts Institute of Technology,  
Lincoln Laboratory,  
Lexington 73,  
Massachusetts, USA.*



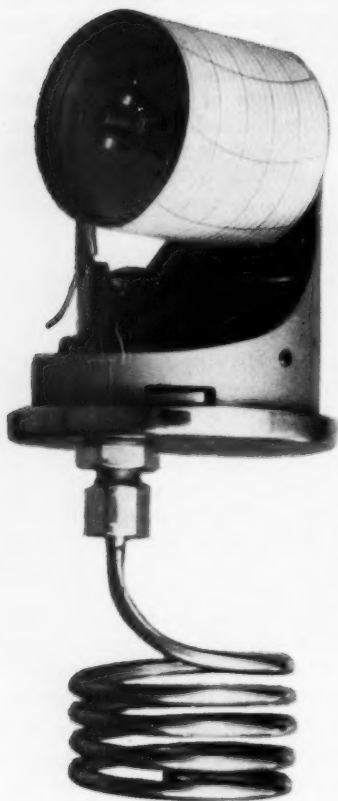
*With a read-and-write cycle time of 0.8 microseconds, the memory has been working satisfactorily since July. Left, the memory elements, which are circular spots of Permalloy film evaporated on a thin glass substrate.*

### Temperature Recorder for Unusual Conditions

FOR use in many unusual conditions—from lorries hauling perishable goods to sterilising processes—Cambridge Instrument Co Ltd have developed a Minican Temperature Recorder, a small self-contained instrument which can be fitted into small spaces.

One anticipated application for the recorder is in the canning and brewing industries where the unit might be sealed in a tin or bottle and the complete instrument passed along a conveyor belt, providing a continuous record of the process temperatures.

The instrument consists of a chart (40-mm-wide) mounted on



*For continuous readings*

a drum which revolves at a constant rate, permitting a pen to trace a temperature record for 2 hours, 12 hours or 24 hours. The pen is moved by the expansion and contraction of the liquid in the stainless steel bulb, which may be either plain or spiral-shaped. The drum is operated by a built-in mechanical clock which runs for one of the three fixed periods mentioned.

In use, both chart and pen are completely enclosed in a chromium-plated brass cylinder which is liquid- and gas-proof and is capable of standing up to high cooking pressures, so that the complete instrument may be enclosed in ovens or cold stores.

Accuracy of 0.5 mm (0.02 inch) on the chart width is to be expected and the minimum range is 50°

across the chart, eg, 120-170°F, or 240-290°F; -30-+20°C or 110-160°C.

*Cambridge Instrument Co Ltd,  
13 Grosvenor Place,  
London, SW1.*

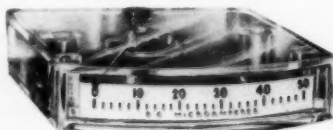
## Miniature Edgewise Meter

A RECENTLY developed Edgewise Meter (Model 220), one of the smallest meters of this type to be manufactured in this country, occupies a minimum amount of front panel space for equivalent scale lengths.

The model 220 has been developed for use in modern complex crowded control panels where front space is at a premium. A very important application particularly in up-to-date computers and multichannel installations, etc, is the ability to mount several of these meters close to one another to facilitate comparative readings. When mounted in this manner, readings are not affected by the proximity of meters, ferrous material, or magnetic fields, as the basic movement is of centre-pole design which provides inherent magnetic shielding. A few examples of the applications for this type of meter are as tape recorder level indicators, 'S' meters, output monitors, indicators, automation and control equipment panels, etc.

The case design of the Edgewise Meter is such that it renders itself suitable for small transistorised assemblies to be plugged in as complete units.

The model 220 can be supplied as a voltmeter, milliammeter, and microammeter, commencing from very high microamps. These



*Occupies a minimum space*

ranges can also be supplied with rectifier for operation on AC supplies. The new Edgewise Meter is available with right hand zero, left hand, displaced, or centre zero pointer position, and is suitable for either horizontal or vertical mounting. The meter's indicator window occupies a space of only 2.5 inches by 0.62 inches, which is less than one-quarter of the panel area for conventional meters of equivalent scale lengths.

*Taylor Electrical Instruments Ltd,  
Montrose Avenue,  
Slough,  
Bucks.*

## New Oscilloscope

THE W M 16 oscilloscope is a wide band instrument with versatile plug-in units. It is designed to meet the needs of electronic engineers working in specialised fields such as radar, television, computers and millimicrosecond oscillography.



*Maximum adaptability with plug-in units*

Features of the instrument are its fast rise time, 10μs, excellent sensitivity of 50 mV/cm, effortless time and voltage measurement 3± percent and versatile sweep facilities.

The instrument's unique plug-in units provide maximum adaptability, and top reliability is ensured by sound design.

The W M 16 has a band width

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of DC-40 Mc/s. It has been designed specially to meet the requirements of overseas markets and will cost £685, when fitted with Wide Band Amplifier Type 7/1.

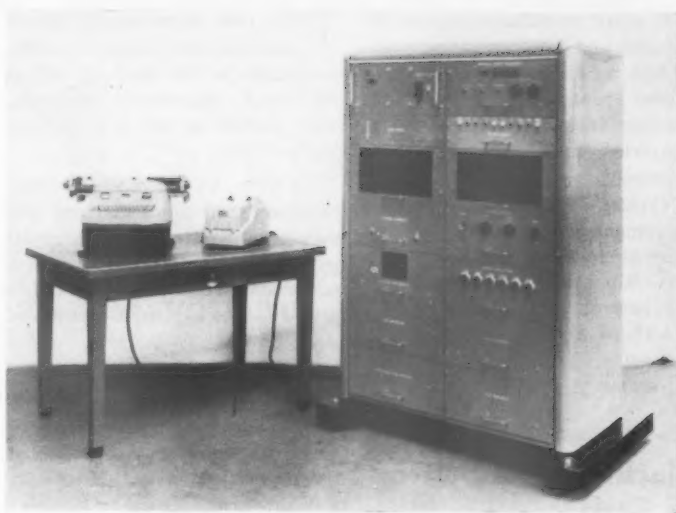
EMI Electronics Ltd,  
Hayes,  
Middlesex.

## SBAC Exhibits

AT the Society of British Aircraft Manufacturers' Exhibition at Farnborough, in September, Solartron exhibited their latest electronic developments in the field of dynamic analysis to the aircraft industry.

—The Solartron transducer, type NT4-313, is a general purpose device operating at standard pressure ranges of 0 to 100 pounds per square inch to 0 to 5,000 psi, gauge or absolute. Lower or higher ranges are available on special order. They are temperature compensated from  $-65^{\circ}\text{F}$  ( $-55^{\circ}\text{C}$ ) to  $+250^{\circ}\text{F}$  ( $+110^{\circ}\text{C}$ ), have an output of nominal 20mV at 5V, DC, or AC, rms (0 to 20 Kc per sec) excitation and a zero shift of not greater than 0.01 per cent of full output per degree F. Their linearity and hysteresis is less than 0.75 per cent, full output up to 2,500 psig,  $\pm 1.0$  percent, full output above 2,500 psig, are  $\frac{1}{8}$  in (15 mm) nominal diameter and 1 inch (26 mm) long.

—The Solartron vibrating cylinder transducer, type NT4-980, is claimed to be unique. It employs an entirely new design principle and is small, accurate and extremely robust as a pressure transducer. The variable frequency output signal makes it especially suitable for magnetic tape recording, particularly with the Solartron data recording equipment; also for analogue-to-digital conversion by pulse counting. The equipment which uses the signal from the transducer can be located miles away from the point of measurement without loss of accuracy.



*Honeywell's system for measuring and digitising variables.*

The pressure sensitive element of the vibrating cylinder pressure transducer is a mechanical vibrating system, whose natural frequency is dependent upon the applied pressure. This vibrating element determines the frequency of an electronic feedback oscillator, thus providing an output voltage of constant amplitude but with a frequency which varies with the pressure applied.

The transducer was developed as a part of a system for recording ramjet data on magnetic tape during flight. For this purpose a transducer with a variable frequency output was found to be the most suitable.

*The Solartron Electronics Group Ltd,  
Thames Ditton,  
Surrey.*

## Data Reduction System

DEMONSTRATED at the SBAC Exhibition at Farnborough last month this data handling system measures and digitises a large number of variables, present in plant data in digital form in light on the unit and—via an electric typewriter—in print on a log sheet. Two features of this system—

accuracy (0.1 percent) and flexibility of operation—should commend themselves to process plant engineers.

*Honeywell Controls Ltd,  
Greenford,  
Middlesex.*

## Data Logger

DATA logging equipment devised from data handling modules developed by Blackburn Electronics Ltd to enable a number of parameters to be monitored continuously were displayed at the SBAC exhibition last month. If any parameter deviates beyond preset limits an alarm is generated and the relevant information concerning the faulty parameter is recorded by an output printer. Also, a complete log of parameter values may be obtained at pre-set intervals of time or on demand.

The basic modules employed in this equipment are a Scanning Switch, a Relay Drive Unit, a Data Amplifier, an Error Detector, a Reference Level and Patch Panel, an A-D Converter, a Digital Clock, and a Printer Drive Unit.

Typical applications of this data logger are the monitoring or logging of strain gauge, thermocouple

and other transducer outputs for research and development purposes.

Also on display was a prototype digital metering system which enables analogue voltages to be converted and displayed simultaneously.

Typical applications for this equipment are the display of data from air traffic control and ground surveillance radar, or industrial process control.

*Blackburn Electronics Ltd,  
Brough,  
Yorkshire.*

## Machine Tool Systems in Paris

A NEW EMI low-priced electronic positioning control system fitted to a specially designed co-ordinate table, was shown to the public for the first time at the Sixth European Machine Tool Exhibition in Paris in September.

Designed specially for the smaller user, the system was demonstrated working in conjunction with a Grimston drill. It will be marketed complete with machine tool at approximately £1,650. This development marks a breakaway from previous electronic control systems which were too expensive to be attractive to the smaller user.

As with EMI's other positioning and machine tool control systems, the Emicon Type C1010 can be controlled either from punched tape, or by knob settings. Both methods are provided as standard in the control cabinet.

Also on show at the exhibition were a giant EMI-Wadkin drill capable of drilling holes up to two inches in diameter in steel to very fine limits; the company's latest electronic equipment for three-dimensional continuous contour control and a two-dimensional positioning control system together with one of EMI's CS3 Dynamic Balancing machines.

*EMI Electronics Ltd,  
Hayes,  
Middlesex.*

TWO new economically priced machine tool control systems, acceptable to the small as well as the large engineering company, were shown for the first time by Ferranti Ltd.

These systems—transistor hydraulic continuous machine tool control equipment, and numerical positional machine tool control equipment—represent an attempt to provide less expensive automatic equipment.

1—The continuous control system operates from normal electricity mains which eliminates the use of frequency converters used in the former Ferranti system. It is fully transistorised, incorporates hydraulic servo mechanisms and a simplified electro-optical measuring system. Maximum machining time of the new system, compared with the old, has been increased from 40 minutes to 160 minutes because four times as much information can now be stored on magnetic tapes.

The electrical servo motors on the original Ferranti system are now replaced by hydraulic piston motors, controlled by electro-hydraulic valves, resulting in an increase in the over-all structure stiffness of the machine transmission, and peak output of the servo motors has been increased from 0.7 bhp to 3 bhp. Simplified transistor circuitry for each axis of the machine tool is contained in the control console in three easily replaceable or interchangeable trays, thereby simplifying maintenance.

The price of the new system ranges from £7,000 to £12,000 depending on the size and complexity of the machine tool being controlled, which represents a capital cost reduction of at least 25 percent, on any range or application of the previous Ferranti system, and in some instances up to a 50 percent reduction.

2—The numerical positional machine tool control system is an entirely new equipment designed for rapid point-to-point positioning

of machine tools and allied equipment in Cartesian or polar co-ordinates. This system does not require the use of a computer as information is presented to the control console in the form of punched paper tape which can be prepared by the machine tool operator or, alternatively, incremental movement can be accomplished by direct dial setting without using tape.

Measurement of position is by means of the Ferranti diffraction grating measuring system fitted to the machine tool slides or tables.

The company claim that this co-ordinate positioning control system, with feedback checking and monitoring from electro-optical measuring scales, will be applied to a wide range of machine tools because it can be offered at a price of between £2,000 and £3,000, which is normally associated with positioning controls without the feedback or self-checking facilities.

*Ferranti Ltd,  
Hollinwood,  
Manchester, Lancs.*

AUTOMATIC co-ordinate setting equipment was demonstrated at the Exhibition.

The equipment was fitted to a No 3 W B Kearns patent electronic horizontal surfacing, boring, milling, drilling and screwcutting machine manufactured by Messrs H W Kearns and Co Ltd, of Broadheath, near Manchester, and was on show on their stand at the exhibition.

The electronic control of the equipment enables the table and spindle slide to be set to an accuracy of 0.0002 inch with information set either manually by setting rotary dials on the electronic control desk, or, automatically by punched cards which are fed through a specially designed punched card reader.

*Associated Electrical Industries Ltd,  
(Electronic Apparatus Division),  
New Parks Factory,  
Leicester.*

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*proven reliability from years of experience • proven reliability from years of experience • proven reliability from years of experience*

*from years of experience • proven reliability from years of experience*



**FERRANTI**  
can get you out of this!

**you are ready for a**

**FEDPS**

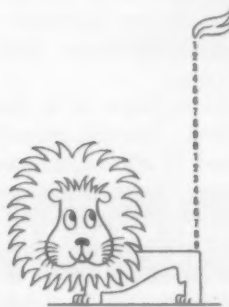
*Ferranti Electronic Data-Processing System*

If your problem is one of handling huge volumes of documents FERRANTI, the first company to market any electronic digital computer, can solve it with the PERSEUS and PEGASUS Electronic Data-Processing Systems based on magnetic tape, the new medium for clerical mechanisation.

PERSEUS the most powerful system in Europe is for large organisations and groups of companies, while PEGASUS, a most versatile system, is ideal for medium-sized establishments, especially those with commercial and technical applications. PERSEUS and PEGASUS bring

*proven reliability from years of experience.*

They are fully supported by systems-study, training, programming and maintenance services.



*Does the  
Lion's share  
of the work!*

**FERRANTI LTD** WEST GORTON • MANCHESTER 12

Telephone: EAST 1301

London Computer Centre: 21 Portland Place, W.1. Telephone: LAngham 9211

## GETTING TO KNOW THE DRILL

*continued from page 38*

The research workers have not been entirely satisfied with this latter experiment. Workers used to a factory environment often have a highly-developed hearing sense and may still distinguish the machine sounds behind the oscillation. It is possible that the only effective way of excluding the hearing sense is to silence the machine.

Workers in the department have carried out some of the experiments, but industrial workers from factories have also been introduced to operate the drill.

### VARIOUS METALS

Various materials have been used in the experiments—free cutting steel, silver steel and carbon steel, and bars plugged with different metals, including aluminium, silver steel, and some solid bars. All the metals used have had the same colour so the operator has not known what material is being worked until the actual drilling operation commences.

In addition to experiments with human operators, a mechanical control has been fitted

to the drill to obtain recordings under automatic control. There are control boxes which can be pre-set so that any excess of speed, torque, thrust, etc, over the pre-set level reverses the drill and ejects it.

The mechanical feed can also be engaged and reversed by a hand control. An operator using this control can start the drill feeding downwards by pulling a lever down, or switch it into reverse by pushing it up. He cannot feel the pressure being applied to the job, so that this pressure sense is eliminated as a control factor, just as the eyesight sense was eliminated by blindfolding.

From industrial experience it is clear that the solution does not lie in just one factor, e.g. that of controlling torque. The problem is to find when the change of control (for example, from torque to pressure) occurs. It may be that more than two control methods are involved.

By making a comparison of the graphs recorded under all these conditions it is hoped that the wide variation in performance will show which factors are important in the control of a sensitive drill. If these can be isolated then it would undoubtedly be possible to develop industrial equipment to sense them, and use them to control the machines.

## NAMES AND NOTES *continued from page 15*

Earnshaw, C D H Webb, Dr Denis Taylor, W W Hopwood (USA), M J Boho (USA) and C W Sengstaken (USA).

### Call-up by Computer

THE First United States Army has put to work a Remington Rand Univac electronic computer that could speedily call more than 400,000 reservists to active duty.

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'This answers the need for maximum preparedness in these critical times. The computer has the capacity to assume far greater work-load in maintaining records and reporting status without corresponding increase in manpower.'

First Army Headquarters are at Governors Island, at the foot of New York City. The Governors Island automatic data processing centre is the forerunner of similar installations planned for five other field Army Headquarters in the United States during the next few years.

### Exhibition Dates

THE tenth International Office Equipment Exhibition will be held in Paris from October 16-25. Accounting machines, punched card equipment, and data processing systems will be among the office hardware on show from 17 countries.

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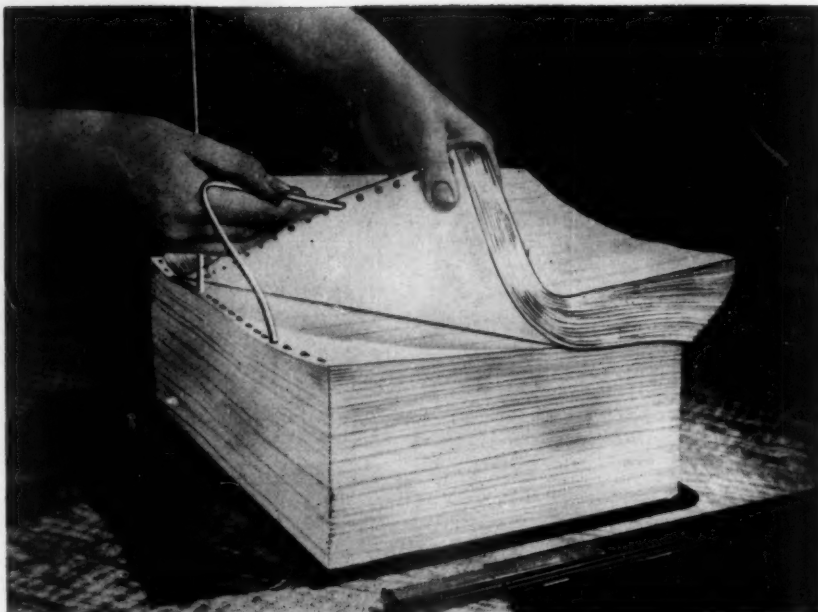
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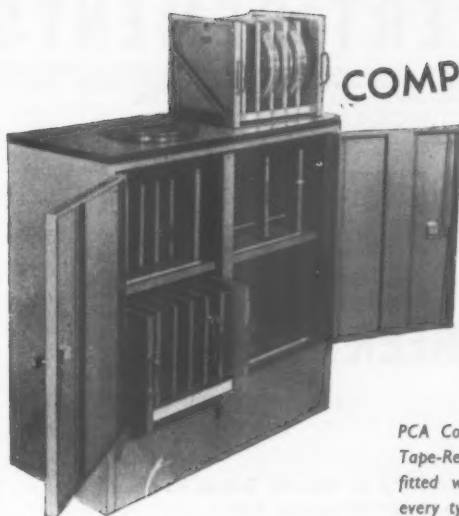
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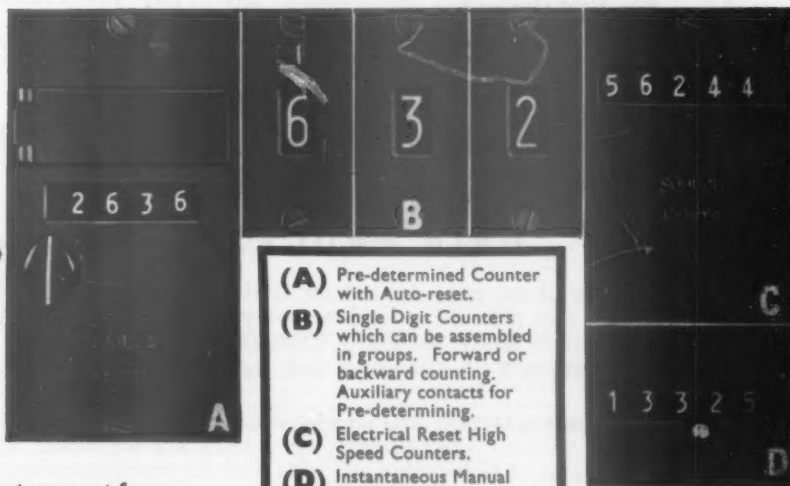
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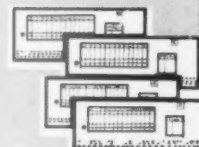
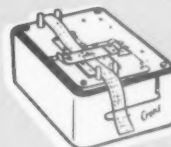
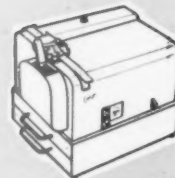
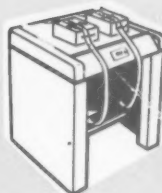
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